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# ELECTRON MICROSCOPE INVESTIGATION OF OPAL GLASS

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**Abstract**

The electron microscope is a useful tool for the detailed study of glasses containing a dispersed phase (gases and crystals) which cannot be disclosed with the light microscope. Eleven samples of commercial opal glass and two opalescent glasses made in the laboratory have been subjected to a preliminary investigation by means of the replica technique.

Calcium fluoride glasses show well defined fluorite octahedrons and cubes either in clusters or scattered uniformly over the surfaces studied. Sodium fluoride glasses commonly contain clusters of globular forms having within them small crystals which appear to be cubic.

The crystals found projecting from the broken glass surfaces range from 0.04 to 0.8 microns in diameter while in some samples a group of larger crystals (1.0 to 3.0 microns) also is present. In the specimens studied there are from $10^7$ to $10^8$ crystals per square centimeter of surface. Bubbles are present in all the glasses investigated. They vary in number from approximately $10^8$ to $10^9$ per square centimeter of surface and in diameter from 0.03 to 0.08 microns in the various samples.

## I. Introduction

The crystals and bubbles in commercial opal glass can be readily observed with the electron microscope. By using the replica technique developed for high magnification work with metals and other substances opaque to the electron beam[1, 2, 3] the features of both the dispersed and glassy phases of opalescent glasses and enamels can be studied. The shape, surface features, particle size, and distribution of crystals and crystal aggregates are easily seen and measured. In addition, many structures are found in the micrographs which, at the present stage of the investigation, are difficult to explain. Electron microscope work on glass made under closely controlled conditions may not only provide explanations but yield additional fundamental information on the nature of opalescence.

In the present study all of the electron micrographs were obtained by breaking the glass and reproducing the details of the fresh or subsequently etched surface in a collodion replica which was then photographed in the electron microscope.

A chemical analysis and x-ray diffraction data was obtained for each sample. Most of the accompanying micrographs were made on commercial opal glasses which were furnished by the manufacturers. A few were obtained from samples made in connection with research work in the Department of Earth Sciences at The Pennsylvania State College.

## II. Review of Literature

Although the electron microscope has been used effectively for the investigation of ceramic raw materials, its application to the study of ceramic products has been limited. Despite the suggestions of a number of authors[4, 5] that surface studies of ceramic bodies with the electron microscope are practical and would be of interest, little work of this nature has been done. Glass surfaces have been investigated by E. Golz[6, 7] and by N. J. Kreidl[8]. Gold particles in ruby glass have been photographed by B. V. Borries and G. A. Kausche[9] who postulated that the particles were octahedral as revealed by triangular, square, hexagonal and octagonal cross sections. Bachman, Fischer and Badger[10] have also made electron micrographs of gold in ruby glass, and recently micrographs have been taken showing crystals of rutile and anatase in titanium-bearing enamels.[11]

In the study of color and opalescence in glass, the importance of size, shape, number and distribution of the particles of the dispersed phase has long been realized. W. A. Weyl[12] has given a thorough summary of the work which has been done ever since the slit ultramicroscope was effectively used by Zsigmondy[13] in 1909 to obtain

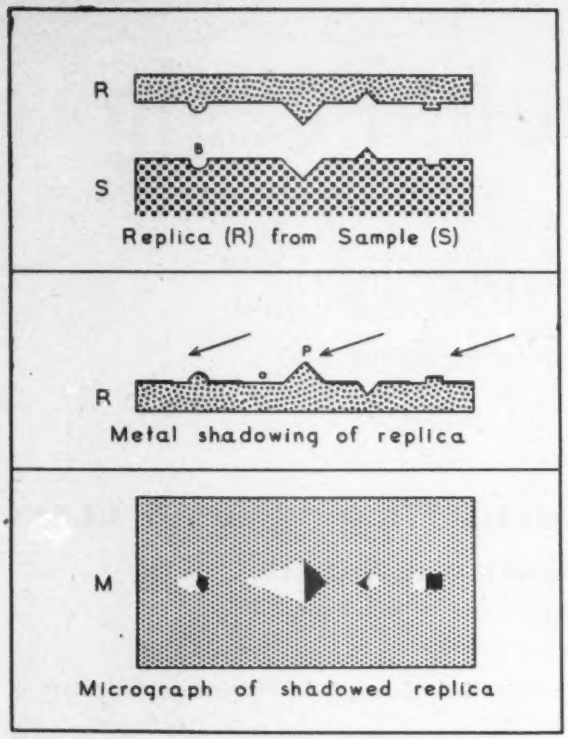


**Fig. 1. Steps in the preparation of a negative replica.**

data on the color and particle size of colloidal gold in glass. Ryde and Yates[14] found by microscopic measurements that the particles in ten fluorine opal glasses ranged in size from 0.35 to 1.3 microns with one sample having particles from 3.0 to 20.0 microns in diameter. Dunbar[15] (p. 417) states that, for the glasses he investigated: "The average particle sizes—lie in the range 0.3 microns to 4.5 microns, and the concentration between $10^7$ and $10^{12}$ per cm.$^3$. By far the greater number of glasses have average particle sizes which are between 0.3 micron and 1.0 microns, and it seems fairly safe to say that most commercial glasses have average particles which lie in this range." The same author pointed out that many of the glasses contained particles of two different sizes and that "— both classes of particles obey the same general distribution laws as have already been described for glasses containing only a single class of particle. It is probable that the two classes of particles have actually a different chemical composition."

X-ray studies have shed much light on the composition of the crystalline phases of opal glass and have also contributed significant information on particle size. Büssem and Weyl[16], for example, obtained diffraction patterns of glasses containing $Na_2O$ and $F_2$ which gave well defined, continuous NaF lines but also spotty diffraction effects due to coarser cristobalite crystals.

The effect of particle shape on the color and opalescence of glass is not thoroughly understood, one reason being that until the development of the electron microscope there has been no direct way of observing, in any detail, the morphology of the particles. Using the method developed by R. Gans, B. Lange[17,18] has shown that the polarization of the Tyndall light from particles

TABLE I

| Sample Number | 1 | 2 | 3 | 4,5,6 | 7,8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|
| Crystalline Phase | NaF $SiO_2$* | $CaF_2$ | NaF | $CaF_2$ | $CaF_2$ | $CaF_2$ | $CaF_2$ | NaF $SiO_2$* | | |
| $SiO_2$ | 70.0 | 68.0 | 68.5 | 64.1 | 64.6 | 68.9 | 64.1 | 72.9 | 44.0 | 52.0 |
| $Al_2O_3$ | 9.2 | 7.5 | 3.5 | 5.9 | 5.9 | 5.4 | 7.3 | 6.6 | | |
| $Fe_2O_3$ | | | | | | | | | | |
| CaO | 0.5 | 6.2 | 4.5 | 10.8 | 10.9 | 0.2 | 0.1 | 1.5 | | |
| $Na_2O$ | 16.5 | 14.2 | 13.5 | 12.2 | 12.2 | 8.9 | 6.9 | 4.6 | | |
| $K_2O$ | | | 2.0 | 2.4 | 1.9 | 2.9 | 4.0 | 0.7 | | |
| $F_2$ | 2.7 | 3.2 | 3.6 | 7.1 | 7.0 | | | | | |
| $CaF_2$ | | | | | | 7.3 | 12.8 | | | |
| NaF | | | | | | 5.4 | 4.6 | 13.5 | 20.0 | 26.0 |
| BaO | | | | 0.1 | 0.2 | | | | | |
| ZnO | | | 3.0 | | | | | | | |
| $B_2O_3$ | | | 0.7 | | | 0.8 | | | | |
| $As_2O_5$ | 1.0 | 0.7 | | | | | | | | |
| $TiO_2$ | | | | | | | | | 36.0 | 22.0 |
| Total | 100.0 | 100.0 | 99.3 | 103.0 | 102.9 | 100.0 | 99.9 | 100.0 | 100.0 | 100.0 |
| $O_2$ equivalent of $F_2$ | | | | 3.0 | 2.9 | | | | | |
| | | | | 100.0 | 100.0 | | | | | |

*Cristobalite

in solution depends on their shape as well as size and has applied this method to the investigation of opal glass. In his discussion of the problem, Weyl mentions several observed phenomena which, for their explanation, require a departure of the particles from a spherical shape.

### III. X-Ray Diffraction Data-Chemical Analysis

The x-ray diffraction patterns of the commercial opal glasses show, in each case, one or more crystalline phases which could be readily identified. These are given in Table I at the top of each analysis. The presence of cristobalite in samples one and eleven is suggested but not definitely established. X-ray studies of samples 12 and 13 did not reveal the presence of any crystalline material even though opaque particles and aggregates are very common in the electron micrographs.

Chemical analyses of samples 1-11 were furnished by the company which contributed the sample. The figures for samples 12 and 13 were obtained from the position of the specimens on the ternary diagram $SiO_2$-NaF-$TiO_2$.

### IV. Preparation of Samples

The following technique was used in obtaining the micrographs. All of the pictures were obtained from replicas of freshly broken surfaces of the glass sample. Both etched and unetched surfaces were investigated. Etching was done at room temperature with a solution containing one part of 48% hydrofluoric acid in three parts of water. The acid was allowed to remain on the glass for periods of from two to ten seconds before being washed off with distilled water. Longer etching was not practical because of the difficulty of stripping the collodion replica from the rough surface produced.

The glass surfaces were investigated by means of the "negative replica" method illustrated in Fig. 1.

A film of collodion (R) is stripped from glass surface (S) with scotch tape and "shadowed" at a low angle with chromium evaporated from a tungsten filament "basket". Areas where chromium is absent, such as at "o", appear as light areas in the print and represent the "shadows" of adjacent projections in this case, "P". Shadowing brings out the relief and suggests the height

**Fig. 3. Surface of glass shown in Figure 2 after 10 second etch with HF. Streaks in background are from the plate and are not characteristic of the surface.**

**Fig. 2. Surface of a $CaF_2$ opal glass.**

**Fig. 4. Clusters of small crystals in another $CaF_2$ glass.**

of the object casting the shadow. It also serves to distinguish a projection on the film from a similarly shaped depression in the film since no shadow can be cast by the latter. In many cases some of the crystals which are loosened by breakage of the surface, with or without subsequent etching, are picked up and held on the collodion film. These minute particles commonly appear in the micrographs as opaque areas.

In order to interpret the micrographs properly it is important to note that an object which appears as an elevation in the picture (and as such has a shadow) represents an elevation on the collodion replica and therefore a depression in the original surface of the glass. Bubbles in the glass, for example, will always appear as elevations on the collodion film and will cast shadows.

Fig. 5. Surface of a NaF opal glass.

## V. Electron Micrographs

The electron micrographs were taken at initial magnifications of five to eight thousand diameters. The scale shown on the pictures is one micron (0.001 millimeter).

Figure 2 represents the broken surface of sample No. 2, a typical $CaF_2$ glass. The crystals are well developed octahedrons or cubes, or combinations of both. Hexagonal shapes represent cubes viewed along a body diagonal or are due to the presence of cube faces truncating the corners of an otherwise triangular octahedron face. The streak in the matrix appearing on the same side of each crystal results from breakage of the glass and is removed on the deeply etched surfaces as, for example, in Figure 3.

Bubbles are present to a varying extent in all the samples studied and are particularly well brought out by etching. This is seen in Figure 3 which shows the surface of the same glass (No. 2) after a 10 second etch with hydrofluoric acid. The bubbles often occur at the face of or closely associated with a crystal. This may be seen at "A" on the crystal and at "B" where the small projection into the bubble probably represents the point of an octahedron which lies beneath the surface. The etching attacks the crystal faces more rapidly than the edges giving rise to curved surfaces and finally skeleton crystals.

The micrograph in Figure 4 shows a departure from

Fig. 6. Large crystals associated with globular forms in a NaF glass.

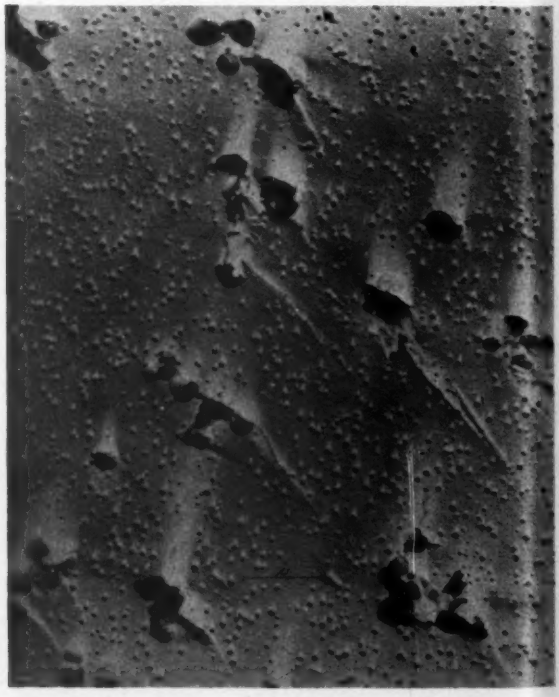

Fig. 7. Surface of glass shown in Figure 5 after 10 second etch with HF.

the typical structures shown in the preceding pictures. Taken from another sample of $CaF_2$ glass (No. 7) it is characterized by crystals associated in groups rather than scattered uniformly throughout the matrix. In addition the crystals are somewhat smaller.

The unetched surface of sample number 3, a typical sodium fluoride glass, is pictured in Figure 5. The three glasses studied which had crystals of this composition all showed this characteristic grouping of "globules" in a matrix dotted with bubbles. As seen in this figure and in Figure 6 of sample number 11, crystals commonly occur on the edges of these rounded structures.

After a 10 second etch the surface of the glass shown in Figure 5 takes on the apearance illustrated in Figure 7. Two features are of particular interest. Many of the globular forms show web-like structures possibly due to the presence of "ribs" of slightly more resistant glass. Secondly, the bubbles are particularly well shown and are quite uniform in diameter and overall distribution, although there is a tendency for some of them to be aligned in chains.

The globular forms also appear in sample number 9 of calcium fluoride glass as shown in Figure 8. Occasionally the "globules" resemble cubes and octahedrons with rounded edges and corners.

Figure 9 of sample 3 shows another feature found in both sodium and calcium fluoride glasses. The presence of the unusually large crystals probably caused the glass to break along the surface shown in the picture. Electron micrographs of this specimen and several others show particles of two notably different sizes, and corroborate the findings of such workers as Dunbar[15] and Büssem and Weyl[16] referred to in a previous section. The "wrinkles" between and around the crystals are only seen in the "shadowed" areas and are due to differential stretching of these portions of the collodion film in the heat of the electron beam.

Another structure common to many of the glasses is shown in Figure 10 of sample number 5 unetched. Several features of the micrograph are of interest. The fracture of the glass in the vicinity of the dendrites is smoother than that of the matrix in general. Bubbles are found in the dendrites often at the tips of the "branches". In several cases the branches terminate in four-sided

**Fig. 9. Unusually large crystals characteristic of many of the surfaces.**

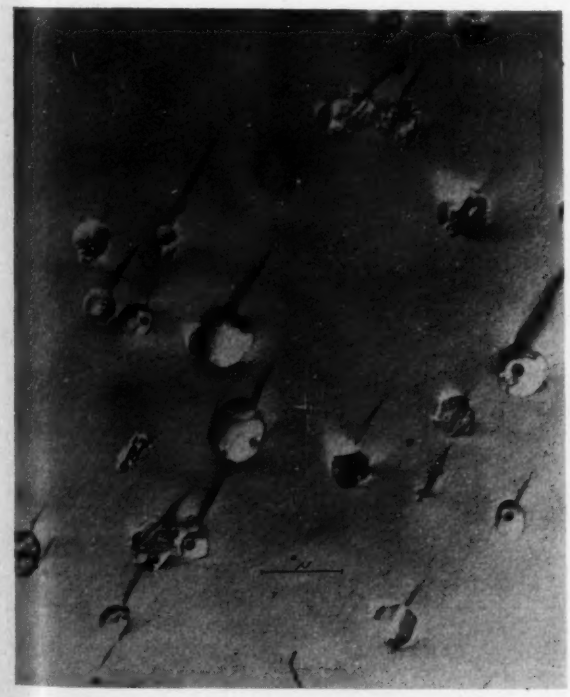

**Fig. 8. Globular forms on a $CaF_2$ glass surface.**

**Fig. 10. Dendritic structures.**

polygons of distinctive shape. It is planned to investigate further the mechanism of this crystallization procedure.

In addition to the glasses furnished by several of the manufacturers, two samples were studied which were made in the laboratories of the Earth Sciences Department. From the position of samples of these compositions in the system $SiO_2$-NaF-$TiO_2$ it is to be expected that crystals in sample 12 would be anatase or rutile while those in sample 13 might be tridymite. X-ray diffraction patterns, however, did not give any indication of crystalline material in either case.

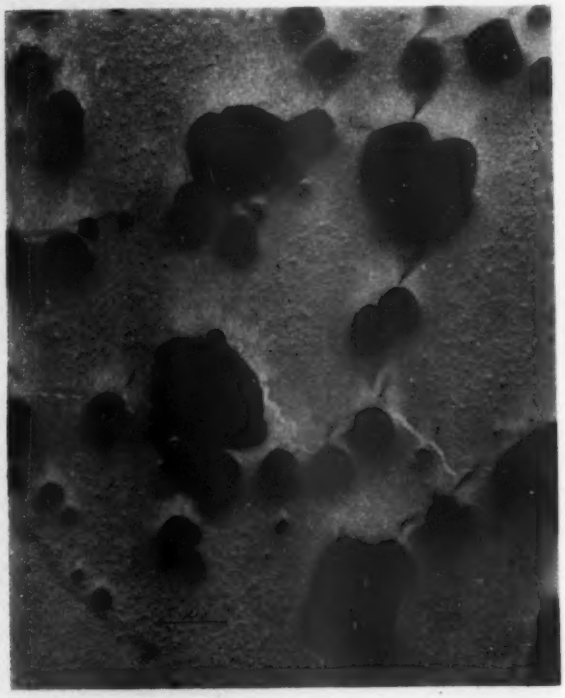

**Fig. 11. Crystal aggregates adhering to collodion film. White jagged lines are cracks in the collodion.**

Micrograph 11 of sample 12 shows aggregates which were pulled off the surface of the glass with the collodion. Where they occur singly the small individual particles seem to be square or rectangular in outline. In the figure the smaller aggregates are commonly thin enough near the edge to permit transmission of the electron beam and resolution of some of the individuals making up the group. Although the clusters are frequently round, many have assumed a square or rectangular shape resembling that of the particles and suggesting orientation of the latter within the aggregate. Crystallization did not take place uniformly throughout the glass but in patches characterized by a roughness of surface not seen where aggregates are absent (lower left corner of figure). Within each patch, however, the glass matrix breaks with a relatively smooth surface in the immediate neighborhood of the clusters. Figure 12 is a picture made from a surface of the same glass after a five second etch. Scattered single crystals are present and replicas of the aggregates are shown. The scalloped edges of the latter suggest the presence and approximate size of the small crystals which make up the clusters.

Somewhat similar features are found in Figure 13 taken from an etched surface of sample 13. Some of the black areas are darker in the center suggesting that they are aggregates of tiny particles, and serrated edges on white replicas (as at A) tend to corroborate this possibility. Two lines of evidence indicate that the rounded bodies are disc-shaped rather than spherical. First, the low gray elevations on the collodion represent

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**Fig. 12. Surface of glass in Figure 11 after 5 second etch.**

**Fig. 13. Disc-shaped bodies (black) and their replicas.**

# CONTAINER GLASS COMPOSITIONS—1947

**By A. G. ALLEN and A. K. LYLE**

**Hartford-Empire Company, Hartford, Conn.**

Container glasses in 1947 are of particular interest because it was a year of major changes in glass, forced principally by a shortage in soda ash. Since 1932 there has been a steady almost straight-line change in container glasses marked by declines in silica and alkali, and by a corresponding increase in lime. The data from the 1947 glasses show some interesting departures from the general trends.

The average rates indicated by the 1932 to 1946 averages, presented by Moore and Lyle[1], show a yearly decline in silica of 0.13%, in alkali of 0.09%, and a yearly increase of 0.22% in the total of alumina, lime, magnesia and barium oxide.

The survey of 1947 glasses was based on data from eighty-two samples, of which sixteen were amber, one blue, two light green, and sixty-three flint. Each glass was analyzed and subjected to measurements of homogeneity, seed count, chemical durability and thermal expansion.

The average compositions and test data of 1946 and 1947 glasses are presented in Table I.

In chemical composition, the average 1947 glass is 0.8% lower in alkali and fluxes, 0.3% higher in silica, and 0.4% higher in lime than the glass of the previous year.

As a consequence of the lower alkali, the 1947 glass represents a substantial increase in resistance to chemical attack both by dilute acid and by water. The low alkali contributes, also, to greater resistance to thermal shock.

TABLE 1

A Comparison of Averages of 1946 and 1947 Glasses

| Chemical Composition | 1946 | 1947 | Difference |
|---|---|---|---|
| $SiO_2$ | 72.1 | 72.4 | + 0.3 |
| $R_2O_3$ | 1.8 | 1.9 | + 0.1 |
| CaO,MgO,BaO | 10.1 | 10.5 | + 0.4 |
| $Na_2O,K_2O,B_2O_3,SO_3,F_2$ | 16.0 | 15.2 | — 0.8 |
| **Test Results** | | | |
| Homogeneity | B | B— | — 1 |
| Seed count per oz. | 20 | 30 | +10 |
| Chemical Durability, $H_2O$ | .035% | .031% | — .004 |
| Chemical Durability, Acid | .050% | .040% | — .010 |
| Thermal Expansion $\times 10^7$/°C. | 91 | 87 | — 4 |

Other apparent results of the lower alkali is an increase in average seed count, and a decrease in homogeneity. However, it must be remembered that the shortage of soda encouraged the use of foreign cullet, and also that almost all manufacturers experienced fuel shortages. Foreign cullet is a common cause of cords and, of course, fuel and furnace temperatures are related directly to seedy glass.

A detailed study of alkali contents, in relation to both seeds and homogeneity, shows an almost complete lack of correlation.

Seed counts of less than thirty per ounce occur as frequently in glasses of less than 14% alkali as in glasses of more than 15% alkali. Among the seed counts greater than 100, there are four among glasses above 15% alkali

[1] "Container Glass Compositions 1932-1946", H. Moore and A. K. Lyle, The Glass Industry, 28, 11, (563-566), Nov. 1947.

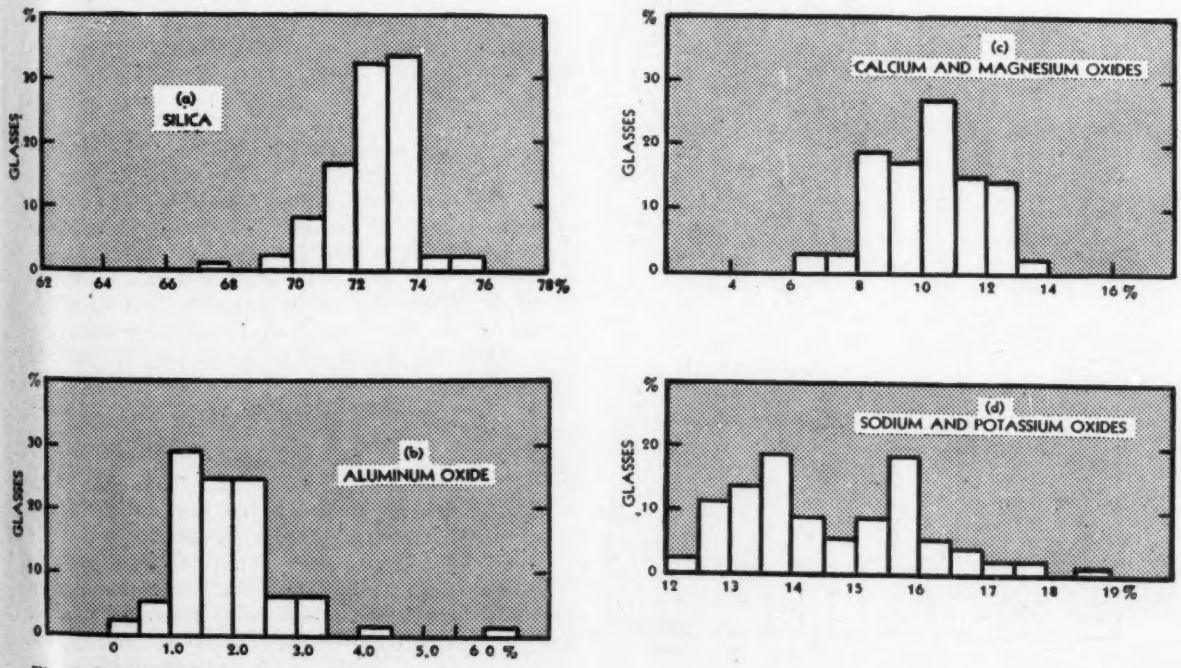


Fig. 1. Major Oxides.

and four among those below 14% alkali. There seems to be no basis for attributing the higher average seed count to the general decrease in alkali.

A similar picture is presented in attempting to correlate homogeneity with alkali content. In fact there are proportionately more gradings between B+ and B— among the low-alkali glasses than among those high in alkali.

This might be explained if it were known that foreign cullet was more generally employed in the high-alkali composition which, of course, is likely to have been the case.

After eliminating the composition, particularly low-alkali content, as a factor in slight decreases in average seed and homogeneity quality, it must be concluded that many manufacturers were able to solve the soda ash problem without sacrifice of quality.

In the general trends of composition, the most important change has been in lime content. In 1947, however, the decrease in alkali was by far the most important change, the decrease being absorbed almost equally by increases in silica and lime. In this connection, it is interesting to note that, had the 1932-to-1943 trend toward lower alkali been continued from 1943 on, the predicted alkali content of 1947 would have been almost exactly as found.

This may be taken to indicate the probability of further changes in container glasses, from purely technological considerations. Some manufacturers may have reached practical limits in high lime and low alkali, but for many others a large margin for change continues to exist. A decrease in the range of compositions may be expected as time goes on.

While the averages present the simplest and most concise basis for comparison, the ranges of the major oxides, and some details concerning the use of minor constituents, permit a more accurate appraisal to be made.

The major oxides are presented in Fig. 1. Compared to 1946 there are fewer glasses of less than 72% silica, and a greater number of more than 73%. The most prevalent percentage of alumina lies between 1.0 and 2.5. There is little change in lime except for the increase in the number of glasses containing more than 11%.

The distribution of alkali percentages presents the most interesting picture. Glasses appear to be divided almost equally between low and high-alkali groupings. One group is located below 14.5% with an average about 13.5%, and the other is centered about an alkali content of 15.7%.

Of the minor constituents, presented in Fig. 2, the most interesting is fluorine. In 1946, about 50 per cent of the glasses contained fluorine. In 1947, 80 per cent contained fluorine in important amounts. The fluxing power of fluorine is well known, and for this reason fluorine may very well be the most important substitute for alkali. Examination of the data shows that all of the glasses of less than 14.5% alkali contained some fluorine, while this was true of only a very few of the higher alkali glasses.

The use of calcite and dolomite, and of apparent mixtures of the two, is of interest because since 1937 there has been a steady increase in the popularity of calcite. In 1937 only ten per cent of the glasses were made with calcite. By 1943 the percentage had increased to nearly forty, where it has remained to the present.

In the 1947 survey, 38 per cent are dolomite glasses, 37 per cent calcite glasses, and 25 per cent mixed glasses containing an appreciable amount of magnesia but less than that required by the dolomite ratio. The reasons

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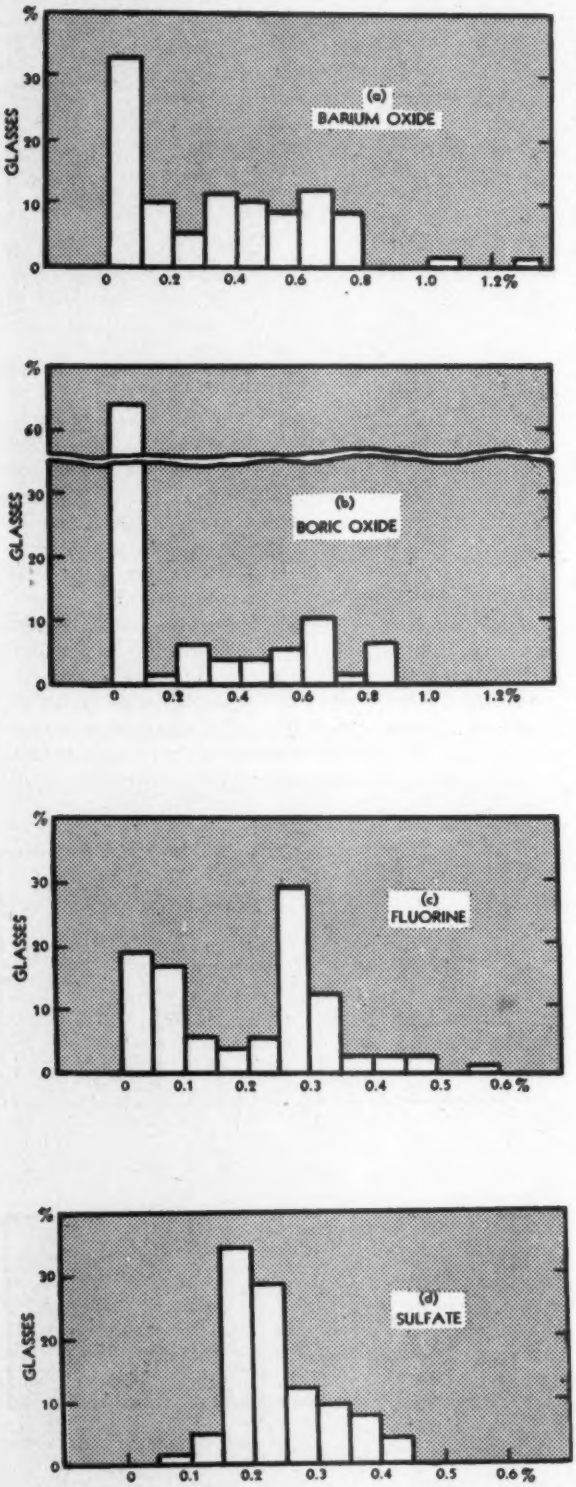



**Fig. 2. Minor Constituents.**

# THE MODERN GAS PRODUCER

By L. L. SWIFT

The present scarcities and high prices of natural gas and fuel oil are making it necessary to consider the relatively few substitute or replacement fuels that are available. In many instances the modern gas producer may be easily and economically adapted to the heating processes that are restricted or may be entirely shut down due to the short supply of usual fuels. The gas producer however has its limitations as well as advantages and we will try and set forth the pertinent facts so that anyone confronted with a fuel problem may be able to decide whether or not a gas producer would be a solution to his particular problem.

Some twenty-five years or more ago every engineer or operator having responsibilities in the design and construction of furnaces, tanks, kilns, etc., was quite familiar with the producers available at that time and few installations were made that could not be easily changed to producer gas firing although natural gas or oil was expected to be used. Since that time the apparently inexhaustible supply of natural gas and oil has created a condition such that many furnaces can use producer gas only after rather extensive alterations and many of the fuel engineers and operators are vaguely familiar with a gas producer only as a source of dirt and smoke.

A brief review of the fundamental process of making producer gas would seem to be advisable. Figure 1 illustrates this process in its simplest form, it will be observed that fuel is supplied to the top of the fire bed and a mixture of air and steam is supplied below the fire. In operation, fuel and air are supplied and ashes are removed so that the positions of the reaction zones in the producer stay fairly constant. Immediately above the ashes is what may be called the oxidation zone where oxygen and carbon unite making $CO_2$ along with the only production of heat in the producer. Next above is the reduction zone where $CO_2$ combines with carbon to form CO, the steam in the air supply is here broken down with the oxygen combining with carbon to form CO and $CO_2$ while the hydrogen passes through the fire bed uncombined. The top section of the fuel bed is the distillation zone where methane, oil and tar vapor and soot are driven from the fresh fuel by the heat. It should be noted that the reactions in both the reduction and distillation zones absorb heat. The gas made is collected in the space above the fuel bed and conducted to the furnace or other appliance. The combustible constituents of producer gas are carbon monoxide, hydrogen, methane and occasionally traces of hydrocarbons. Generally classified as illuminants these combustibles vary to some extent depending on the fuel used and the method of operation resulting in a heating value ranging from 110 to 165 BTU per cubic foot.

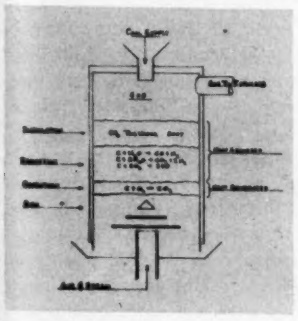


Fig. 1.

The many different kinds of producers having various methods of fuel feeding, ash removal, fire bed agitation, down draft circulattion of air, combinations of up and down draft, etc., are all based on this fundamental process and have as their object the elimination of manual labor, promotion of stable operation and the production of gas of the desired characteristics.

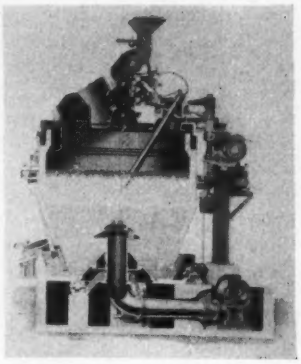


Fig. 2.

Figure 2 shows the Wellman producer which operates on bituminous coal and is fairly representative of the machines using this fuel. It will be noted that this producer has a stationary water cooled top plate on which is located the gas outlet, coal feeding mechanism and an oscillating poker or agitator; the producer shell rotates continuously, has a combination drive gear and track supported on rollers, and ash scrapers at the bottom of the shell which pull the ashes down and outwardly; at the bottom of the producer is the intermittently rotating, water sealed ash pan with its ash plow and extending through the center of the ash pan is the air supply pipe and distributing hoods.

This producer is made in three sizes, 8′-0″, 10′-0″ and 11′-0″ in inside diameter with rated hourly capacities of 2800, 6000 and 7500 pounds of coal per hour. However, these capacities are rarely if ever reached in the course of average operations. The maximum observed rates of operation which can be maintained continuously with average coal are 25, 50 and 60 tons of coal per 24 hours for the three sizes which amounts to approximately 500, 1000 and 1200 million BTU's.

A desirable type of coal for the above producers would be about 1¼ x 1¾ in size, have a low sulphur content and an ash fusion temperature of 2200° F., or higher. Screened coal is to be preferred as slack in quantity will reduce the capacity and increase the amount of fly ash and soot in the gas.

The gas made in this type of producer will have a temperature of 1000° to

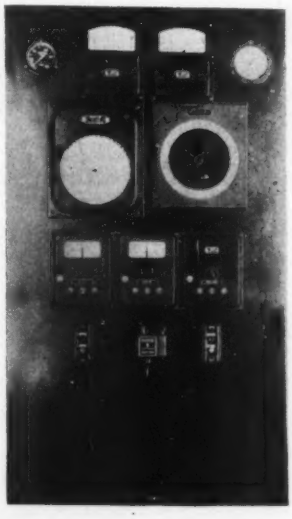


Fig. 3.

Presented before the Ninth Conference on Glass Problems, University of Illinois, Urbana, Ill.

1500° F., in usual operation; contain a considerable amount of tar vapor, some free carbon, soot and fly ash; the heating value will be around 150 BTU per cubic foot. As gas made from bituminous coal is difficult and expensive to clean it is consequently usually used hot and has found many applications for use in melting tanks, pot furnaces, lime kilns, open hearth furnaces, soaking pits, etc., that use large quantities of fuel. The gas burns with a highly luminous flame and the usual high temperatures in glass tanks and open hearths are easily maintained. It has always been customary to use regenerators to preheat producer gas when used in glass tanks and this fact should be considered when applying producers to existing or new furnaces. However, it is well known that producer gas with preheated air will easily maintain a temperature of 2500 to 2600° in steel mill furnaces and the elimination of gas regenerators in glass tanks has been proposed by some authorities.

In years past the various functions of gas producers were manually regulated, usually with a minimum of instruments to guide the operator so it was necessary that he have considerable skill and experience to be able to always keep the producer operating at a rate in accordance with the demands of the furnace. In recent years automatic controls have been developed which regulate the gas pressure and temperature, supply coal as required and control the flow of air to the producer. A typical automatic control panel is shown in Figure 3 which was made by the Hays Corporation. Several other instrument makers also are able to supply similar apparatus.

Figure 4 shows the arrangement of a typical gas producer plant. It will be noted that each producer requires an area approximately 18′ by 30′ plus a railroad track and track hopper for supplying coal. In connection with the space requirements it should be remembered that bituminous producer gas is used hot and requires large brick lined and insulated gas flues. Also some of the fly ash and soot in the gas will be deposited in the flues and will have to be periodically removed. In years past the removal of the soot and fly ash from the gas flues required the shutting down of the furnace and producer for several hours about once a week, opening doors in the flue system permitting air to enter the flue and burn up the soot—being a dirty disagreeable procedure. The generous use of dust catchers and dust hoppers along the gas flue together with steam jets for blowing the deposits to the dust hoppers and hydraulic or pneumatic conveying equipment for removing the ash and soot from the hoppers has in many cases reduced the flue burnouts to once in several weeks or almost entirely eliminated previously objectionable flue cleaning methods.

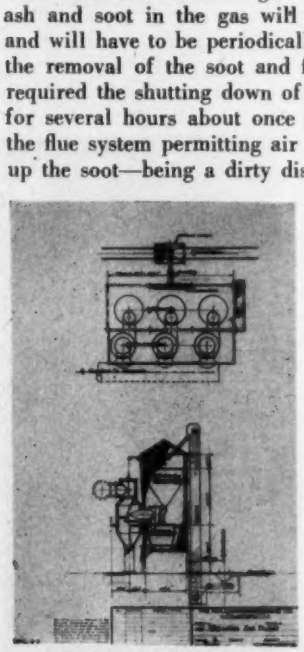


Fig. 4.

A gas producer installation is rather expensive and for that reason is seldom if ever used to supply fuel as a standby. A complete producer plant including a building with coal bin, track hopper and elevator, dust catcher, controls, etc., will cost approximately $60,000.00 to $65,000.00 for the 8′-0″ size, $70,000.00 to $75,000.00 for the 10′-0″ size, and $85,000.00 to $90,000.00 for the 11′-0″ size. When in operation these producers will require about ½ pound of steam from an outside source for each pound of coal gasified. The 8′-0″ and 10′-0″ size will require 300 gallons of cooling water per hour and the 11′-0″ machine will require about 1000 gallons of cooling water per hour. Electric power is also required for the 5 H.P. motor that drives the producer and if the air blower is electric driven instead of by steam turbine an additional 25 H.P. will be required. The attention required by a gas producer is difficult to define in a matter of man hours per day as in some cases one man will be assigned to full time on a producer. In other cases the furnace operator will have time to attend to the producer at all times except when removing ashes or operating the coal elevator.

The above requirements of steam, water, electric power and labor together with a reasonable allowance for repairs and amortization of the original investment will amount to $1.75 to $2.00 per ton of coal gasified or approximately 10¢ per million BTU. With coal delivered at $5.00 per ton, it will be found that natural gas should sell at 35¢ per 1000 cubic feet and oil at 5¢ per gallon to result in an equal fuel cost.

All capacities so far mentioned are based on a ton of coal yielding 20,000,000 BTU. This figure is used largely because it lends itself to easy and safe mental calculations. Actually a ton of average coal will yield 22 to 25 million BTU which is an overall producer efficiency of approximately 90 per cent.

The gas flues connecting the producer to the furnace or other appliance should always be given due consideration as they occupy an appreciable amount of room, are rather expensive in first cost and if not equipped with properly located dust pockets, cleanout doors, soot blowers, etc., they may be a source of constant annoyance. The flues should be designed to give a hot gas velocity of approximately 15 feet per second, insulated to conserve the sensible heat in the gas which also prevents the condensation of the tar vapor. Extremely long gas flues should be avoided as there will frequently be combinations of flue size and capacity wherein the total cost of the gas flues will equal or exceed the cost of the producer plant. A gas flue 6′-0″ in diameter with its lining, dust pockets, cleaning accessories, etc., will cost around $500.00 per lineal foot so it is obvious that long runs are undesirable.

The Wellman-Galusha gas generator shown in Figure 5 has a place in the producer field that is of increasing importance. These units operate on coke breeze or small size anthracite coal, both fuels being comparatively cheap in certain areas. Anthracite has a favorable price relationship in the northeastern section of the country and coke breeze will usually be low priced in the vicinity of steel mills having coke ovens. These machines are made in a variety of sizes from 14″ to 10′-0″ in diameter. The smaller sizes are usually brick lined and the larger sizes completely water jacketed, and some of the intermediate sizes are made in both types. Capacities of the W-G machines vary from 100,000 BTU per hour for the

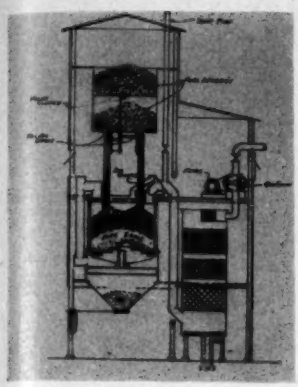


Fig. 5.

14″ size to 30,000,000 BTU per hour for the 10′-0″ size.

The smaller sizes have been used largely for applications requiring a small amount of gas for some special purpose and for supplying fuel to internal combustion engines where the usual engine fuels are not available or are unusually high priced or scarce. It may be interesting to remark we have obtained a horsepower hour on approximately 700 BTU using low speed heavy duty gas engines.

The machines used in industrial heating applications have nearly always been of the 6-6, 8-10 and 10′-0″ sizes. The 8′-0″ and 10′-0″ units are as shown in Figure 5, having an adjustable speed rotating grate, an ash storage hopper arranged to discharge into a truck or other conveyance, two compartment gas tight fuel bin which feeds fuel to the generator as it is used. As previously mentioned these sizes are completely water jacketed and require no outside source of steam as in the usual types of gas producers.

The 6′-6″ machine has a capacity of 7,500,000 BTU per hour when using anthracite and 11,000,000 BTU when using coke; the 8′-0″ size has a capacity of 11,500,000 BTU on anthracite and 17,000,000 BTU on coke; and the 10′-0″ size has a capacity of 18,000,000 BTU on anthracite and 30,000,000 BTU on coke.

In operation, the air is blown across the top of the cooling water where it picks up moisture then it goes down the blast pipe entering below the grates. These machines have a deep fuel bed which cools the gas to a temperature that ranges from 500 to 800° F., at the offtake. Due to the low volatile content of coke and anthracite, the gas made contains practically no tar vapor or soot. As the gas leaves the generator it is fairly clean containing only very small amounts of fine carbon particles and dust. The gas made from anthracite usually contains 150 BTU per cubic foot while the gas from coke contains approximately 135 BTU per cubic foot.

The gas from these generators is usually cooled and washed in a coke filled scrubber and then conducted to a Roots type blower where it is compressed to 3 pounds pressure for distribution through the plant pipe lines. At this pressure the pipe lines are of moderate size and the gas can be piped for long distances without excessive pressure loss or expense for piping.

In some cases the gas is used hot as made after first passing through a brick lined cyclone type dust catcher and then through steel gas pipe insulated on the outside. As these generators are completely tight without water seals, a top pressure of 6 to 8″ water gage may be safely carried in the generator. This pressure has been sufficient to send the gas through upwards of 1000 feet of pipe and if higher hot gas pressures are desirable, a centrifugal gas booster fan may be used to raise the pressure to 1 pound. Installations using hot gas have been in operation for years and the dust deposit in the pipe lines is so small that a quick and easy cleaning once a year is all that is necessary.

The conventional types of burners, control valves, proportioning devices, etc., all readily available, can be used with either the washed gas or hot gas, paying due attention to the sizes of valves and orifices. The sensitivity and response of a furnace using anthracite or coke gas is in every way equal to that obtained with natural gas and is entirely dependent on the kind and quality of controls used.

The washed gas is being used in tunnel kilns, lehrs, ovens, annealing furnaces and many kinds of heat treating furnaces requiring temperatures up to around 2400° F. The hot gas is being used for soaking pits, heat treating furnaces, etc., and has been used in lime kilns.

Whether or not hot anthracite or coke gas could be used in a glass melting tank is a question that has not been definitely determined as yet.

Some of the consulting engineers to the glass industry have considered the possibilities and tentatively expressed the opinion that it could be done. However, the gas whether hot or washed, burns with very little luminosity which possibly would adversely affect the results.

Figure 6 shows a typical arrangement of a W-G gas plant for making washed gas from coke breeze. The large coke storage silo is optional equipment and in many instances is not furnished. It will be noted that each generator unit requires a space of 16′ by 28′ plus a railroad siding and track hopper for bringing in fuel.

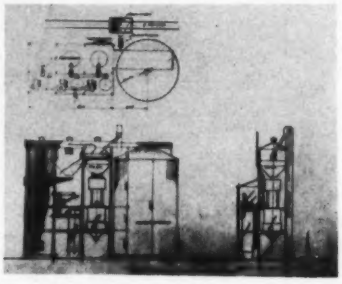


Fig. 6.

These gas generators, like the bituminous type, are expensive and never installed as standby equipment. A complete plant including building, fuel handling apparatus, scrubber or dust catchers and gas pump or hot gas booster fan will cost approximately $25,000.00 for the 6′-6″ size, $65,000.00 for the 8′-0″ size and $70,000.00 for the 10′-0″ size. When in operation, the units will require about 1 gallon of water per pound of fuel used for the water jacket plus approximately 6 gallons of water per pound of fuel used if the gas is to be cooled and washed. Approximately 15 H.P. hours are required for the air blower per ton of fuel used and an additional 40 H.P. hours per ton of fuel used if the gas is compressed to 3 pounds.

One operator can easily take care of 2 or 3 of the 10′-0″ size generators if he has assistance when dumping ashes or running the fuel elevator. In some cases these units have been installed in boiler rooms and the boiler operators take care of the gas generator without additional help.

The above requirements together with an allowance for repairs and amortization charges will result in a gasification cost of $2.00 to $2.50 per ton of fuel used or approximately 12.5¢ per million BTU.

(*Continued on page* 528)

# OWENS-ILLINOIS OPENS THE DURAGLAS CENTER

**Established in the interests of making glass packages more practical, economical and profitable to its own customers, the company's new research activities should prove of value to the industry at large and all glass container users.**

It has been said that the glass manufacturing industry as a whole has been woefully lacking in research. Perhaps on a comparative basis, it has been. However, there have been definite signs of improvement in this vital phase of industrial progress and, highlighting this trend, the Owens-Illinois Glass Company's new Duraglas Center in Toledo, Ohio, is an outstanding example.

In the foreword of a booklet which pictorially describes the functions of this new Owens-Illinois project, Smith L. Rairdon, Vice President and General Sales Manager, states, "It is the conviction of Owens-Illinois Glass Company that research in industry is fully dynamic and effective only when it is focused, when it leaves the plane of laboratory science and is utilized for greater value to the users of the product. This concept is our guide in assisting our customers with their packaging and marketing problems.

"The Duraglas Center is a concentration of scientific forces seeking greater efficiency in the search for the best glass container, the best closure and the best carton; the most efficient means of using them; and the most effective support of a broad market development effort for our customers."

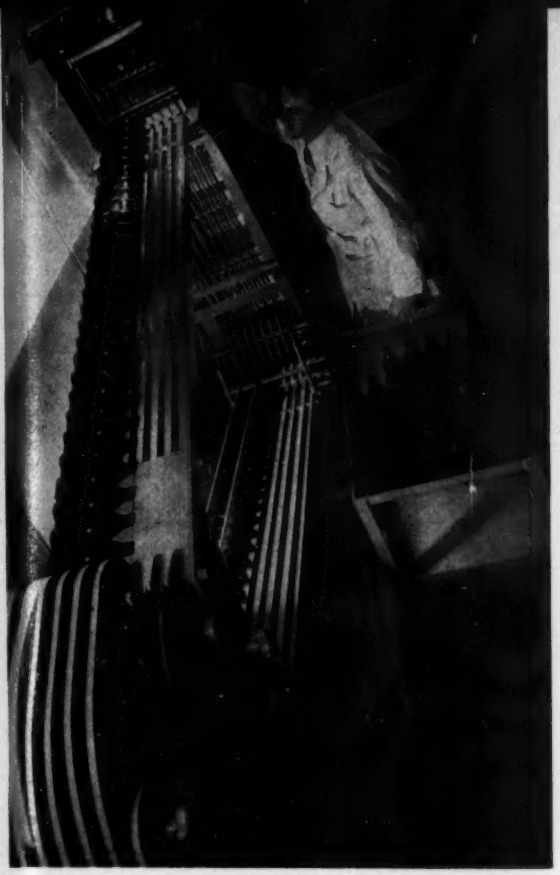
The building housing the Duraglas Center was bought by Owens-Illinois as surplus property from the Reconstruction Finance Corporation through the facilities of the War Assets Administration. A complete change in the exterior appearance of the building was effected, as well as extensive interior alterations.

Multiple installations of the newest types of light-directional Insulux glass block are to be found throughout the Center. This product is manufactured by the American Structural Products Company, an Owens-Illinois subsidiary. Another feature is the use of Kaylo insulation which is a new heat insulating material, manufactured by the same subsidiary, and which was installed throughout the Center before it was ever publicized. Huge doors of highly tempered plate glass have been installed at the main entrance. Glass in many forms, including glass fiber, is used freely in the construction of the building.

In its aim to assist the customer in his packaging problems and aid him in developing his markets, a Consumer and Market Research Department has been set up at the Center. This Department will give the packer the opportunity to have his product and its packaging pre-

**A night-time view of the Duraglas Center.**

**Container quality research laboratory.**



A testing machine which is so new it has not been christened. Some call it a "line abuse" machine since it simulates many experiences that glass containers encounter as they move through the packers' lines.

In the Duraglas Center, bacteriological laboratories are maintained to help assure proper processing and preservation of glassed foods. Here culture media are being prepared for sterility tests.

tested with the consumer. A Container Design Department will assist him in creating his package, giving it a merchandising force through the proper use of labels, style and shape of container, and an efficient closure. The Duraglas Center also offers consultation and engineering service to packers on the processing of their products. Advice is given on the handling of bottles and jars through the packer's lines with a view to obtaining speedy, economical and efficient packaging.

Other facilities to be found at the Center are the Quality and Specifications Department, which includes a glass container quality research laboratory and a shipping case quality research laboratory; Packaging Research Department, which takes in customer package design, closures, processing, product consultation and engineering; Bottle Design Development; Plastics Engineering; Metal Closure Engineering; Consumer and Market Research, Advertising, Publicity and Merchandising.

Mr. Rairdon pointed out that the physical structure of the Center actually summarizes the advantages of the facilities it houses since the building, in itself, is a project of proving research under practical conditions. Company officials expect that the Duraglas Center will enable it to continue the progress which it has made in the past in the development of glass packaging, most important of which was its campaign to make glass containers lighter yet stronger.

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## DR. S. R. SCHOLES RESIGNS AS DEAN OF N. Y. STATE COLLEGE OF CERAMICS

The resignation of Dr. Samuel R. Scholes as Dean of the N. Y. State College of Ceramics at Alfred University has been announced by university officials. Dr. Scholes has been Dean since 1946. He will resume his former position as head of the Glass Technology Department and has been named Associate Dean in charge of curricula and teaching.

Dr. Scholes is one of the Charter Fellows of the American Ceramic Society and one of the small group of Americans elected Fellows of the British Society of Glass Technology.

John F. McMahon, present associate head of the Department of Ceramic Research at the university, will assume the position of acting dean of the N. Y. State College of Ceramics. Mr. McMahon is a graduate of Alfred with post-graduate work at Alfred and Columbia University. He is a Fellow of the American Ceramic Society and a member of the British and Canadian Ceramic Societies and of the state and national societies of professional engineers.

● Huge columns and walls of Murapane, a new colored glass tiling, will be used on 64,800 square feet of surfacing in the United Nations Secretariat in Manhattan. The United Nations architects have selected Murapane in medium blue Temprex.

# BORIC OXIDE—ITS CHEMISTRY AND ROLE IN GLASS TECHNOLOGY

By W. A. WEYL

The Pennsylvania State College, State College, Pa.

PART VII

*2. Low Melting Glasses and Glazes.* In the groups of Jena Apparatus Glass and Pyrex type glasses, the fluxing action of the boric acid is used to produce glasses of superior qualities without raising the melting and fining temperature above the maximum which is commercially feasible. The fluxing action of boric acid can also be used to produce low melting glasses without sacrificing chemical resistivity. This makes boric acid an important constituent of practically all low melting glasses and glazes.

The composition of a commercial low melting glass and glaze is usually very complex. It is the result of experience and laborious experimenting rather than basic knowledge of the system. There is no possibility to predict the influence which a certain oxide has on the various physical and chemical properties. Thermal expansion is usually one of the chief factors to be controlled, because glazes or enamels which do not match the expansion behavior of the supporting glass or ceramic body are likely to produce stresses which cannot be removed by an annealing operation. For labeling bottles for beverages, an enamel has to withstand the corrosive action of the caustic cleaning solutions. Much progress has been made in recent years in improving the alkali resistivity of enamels by additions of zirconia and rare earth oxides. The acid resistivity is another important feature of low melting glasses which has to be considered for many uses. Here the introduction of titania was found helpful. The presence of major amounts of lead oxide and other heavy metal oxides causes a glass or glaze to become sensitive to organic acids containing hydroxy groups. Tartaric acid and citric acid, which are present in fruit juices, form soluble complexes with many heavy metal ions and are therefore much more corrosive than diluted mineral acids having the same hydrogen ion concentration.

A systematic study of simple glasses in the systems $PbO$-$B_2O_3$-$SiO_2$, and $Na_2O$-$B_2O_3$-$SiO_2$ has been carried out by S. P. Varma and S. R. Scholes (1946). A number of glasses were prepared in these two systems with a view to develop a suitable basis for decorative enamels for containers and for glasses of low thermal expansion. These simple glasses, however, need modification for actual use as decorative enamels by adding small amounts of auxiliary oxides like $ZnO$, $ThO_2$, $TiO_2$, etc. which will not materially affect the physical properties, the two most important of which are coefficient of thermal expansion and the softening temperature.

Fig. 11 shows two fields of glass compositions—one containing glasses whose coefficient of linear expansion is about 80-90 x $10^{-7}$, and the other comprising those glasses which have softening temperatures between 550 and 570°C. The shaded zone shows the field of compositions of glasses which meet both requirements. The compositions of some typical glasses of the quarternary field $Na_2O$-$PbO$-$SiO_2$-$B_2O_3$ are given in Table XIV.

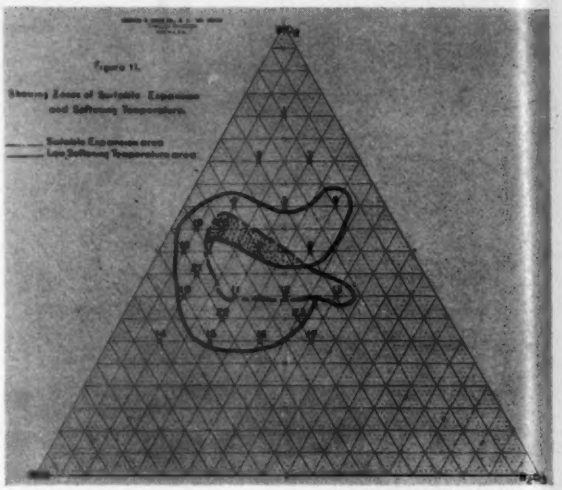

Fig. 11.

TABLE XIV

| Constituent | A | B | C |
|---|---|---|---|
| $SiO_2$ | 47.5% | 38.0% | 52.25% |
| $PbO$ | 38.0% | 38.0% | 33.25% |
| $B_2O_3$ | 9.5% | 19.0% | 9.5% |
| $Na_2O$ | 5.0% | 5.0% | 5.0% |
| Expansion $\alpha$ x $10^7$ | 82.7 | 87.2 | 84.2 |
| Softening temperature | 560°C | 573°C | 572°C |

In Figure 12 is shown the zone for decorative enamels belonging to the ternary system $Na_2O$-$B_2O_3$-$SiO_2$ for low expansion glasses. Some of the glasses that are found suitable for this purpose are given in Table XV.

TABLE XV

| Constituent | A | B | C |
|---|---|---|---|
| $SiO_2$ | 50.0% | 55.0% | 45.0% |
| $B_2O_3$ | 40.0% | 35.0% | 45.0% |
| $Na_2O$ | 10.0% | 10.0% | 10.0% |
| Expansion $\alpha$ x $10^7$ | 42.4 | 40.7 | 43.2 |
| Softening temperature | 627° | 635° | 605° |

The authors report that the above glasses when mixed

with 5% of the auxiliary oxides were found to be satisfactory in respect to chemical resistivity, expansion and softening temperature.

Lead oxide which in itself is a powerful flux was the main constituent of low melting glasses in the past but its use is now being reduced for several reasons. Its fluxing action has to be accomplished by other oxides, for example by the use of combinations of alkalies ($Li_2O$, usually introduced as lepidolite), titania, zinc oxide, fluorine and boric acid. During the war considerable efforts were made to develop lead free glazes. In a paper on the "Development of Leadless Glazes Containing Fluorides" P. M. Corbett and N. J. Kreidl (1942) discuss this possibility very thoroughly.

These authors investigated in particular the use of fluorides as fluxing agents. In reviewing the results of earlier workers and discussing their own findings Corbett and Kreidl realize the importance of boric acid as a constituent of low melting glazes. "The introduction of boric oxide is, by far, more important in lead-free glazes than in lead glazes. The use of boric oxide has been the basis and the main achievement in the development of leadless glazes ever since Seger's first experiments in which he used about 15% $B_2O_3$. Leadless glazes of this type as well as those containing still more boric oxide were worked out and described by various authors. Batch compositions of this type can be found in all important compilations of glass formula.

"In fact, it is extremely difficult to obtain glazes of low maturing temperature which contain neither lead oxide nor boric oxide. Glazes with firing ranges between cone 04 and 06 seemed to require at least small quantities of lead oxide, if boric oxide was to be excluded for any reason."

Their experiments were based on earlier work of W. Steger (1941) who studies the influence of fluorine compounds on the meltability of glazes. In Germany, however, boric acid was just as unavailable as lead oxide, which proved to be a serious handicap in Steger's efforts. By combining the action of fluorides with that of boric acid it was possible to develop lead free glazes which could be improved further by introducing lithia. Corbett and Kreidl came to the following conclusions:

"1) The replacement of small amounts of alkali by $B_2O_3$ provides a wider firing range and a wider field of possible compositions. 2) The glazes where $Na_2O$ represents more than one-half of the $Na_2O + K_2O$ content were superior to those higher in $K_2O$. These glazes were also somewhat superior to those containing only $Na_2O$. 3) With increasing $B_2O_3$ content a certain tendency to opacify at low temperatures was first enhanced and then decreased. 4) With the approach of the complete substitution of $B_2O_3$ for $Na_2O + K_2O$, the glazes became more refractory."

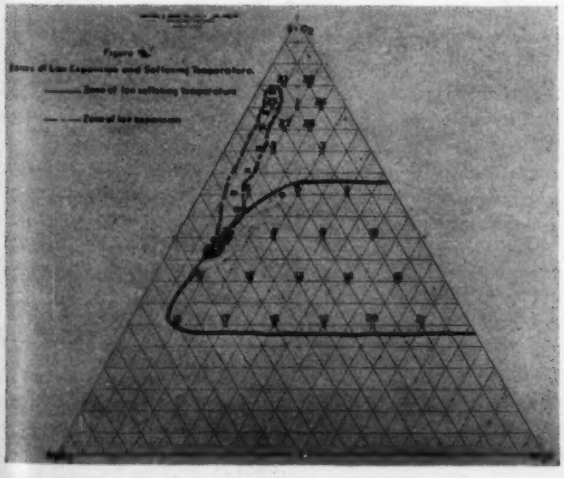

Fig. 12.

Further experiments introduced the boric oxide by addition, rather than by substitution. This way of introducing $B_2O_3$ obviously will not decrease the alkali to the same extent, but was believed to be more suitable in an attempt to increase the firing range. Judging the possibility of producing satisfactory glazes without the use of lead oxide Corbett and Kreidl wrote:

"With our ample supply of $B_2O_3$, we should certainly be aware of the possibility of widening and safeguarding the firing range by systematical studies of the influence of this constituent on fluorine-containing glazes. This also would enable us to decrease their alkalinity."

A. J. Deyrup (U. S. Patents 2,278,867; 2,278,868; 2,282,540 and 2,316,742) developed a series of glazes all of which contained boric acid as a major constituent. The following composition is an example of one of his lead oxide-containing glazes.

| | | | |
|---|---|---|---|
| PbO | 21.0% | $Na_2O$ | 2.5% |
| ZnO | 41.5% | CdO | 4.0% |
| $B_2O_3$ | 21.0% | $TiO_2$ | 1.5% |
| $SiO_2$ | 8.5% | | |

Table XVI gives some compositions of lead free glazes.

TABLE XVI

| | Flux A | Flux B | Flux C | Flux D |
|---|---|---|---|---|
| $B_2O_3$ | 27.0 | 23.8 | 31.6 | 36.0 |
| $SiO_2$ | 50.3 | 51.8 | 46.0 | 43.8 |
| $Li_2O$ | 2.1 | 1.9 | 1.7 | 1.6 |
| $Al_2O_3$ | 6.7 | 8.3 | 7.4 | 7.0 |
| $K_2O$ | 1.5 | 1.8 | 3.8 | .. |
| $Na_2O$ | 1.8 | 2.2 | 0.4 | 3.0 |
| ZnO | 4.2 | 8.4 | 7.6 | 7.1 |
| $ZrO_2$ | 1.4 | 1.8 | 1.5 | 1.5 |
| CdO | 5.0 | .. | .. | .. |

In these glaze formulae boric oxide is introduced as a mixture of $H_3BO_3$ and $Na_2B_4O_7.10H_2O$, zirconium oxide as a sodium zirconium silicate and alumina in the form of clay.

In connection with the use of boric acid as a batch constituent of ceramic glazes, a study on salt glazing shall be mentioned which was carried out by H. G. Schurecht and K. T. Wood, New York State College of Ceramics, in cooperation with a large number of sewer pipe companies.

The formation of the salt glaze is due to a reaction of the clay body with the vapors of volatile compounds of the alkalies (salt) sometimes in combination with cobalt or manganese chloride. A vitreous layer of sodium aluminum silicate forms on the surface of the ware. Salt glazing is used for sewer pipes, chemical stoneware, face bricks, etc. It was the purpose of this coop-

erative work to determine if defects in the glaze could be reduced and the quality of the ware improved by using mixtures of salt with borax or boric acid. These additions had been suggested previously but there were contradictory opinions about their economy and usefulness.

It was found that the use of borax together with salt, if properly used, greatly improved the glaze and decreased the temperature at which the ware takes a salt glaze. Boric acid as well as borax was included in these tests, and it was found that although boric acid costs more than borax, it has certain advantages over borax when used in salt glazing mixtures.

The results indicate that the use of borax or boric acid with salt in salt glazing ceramic ware not only reduces glaze defects which are causing manufacturing losses, but also improves the quality of all of the ware making them better able to meet the specifications.

The best method of salting with boron compounds was found to be by salt glazing with salt alone for the first three saltings while a mixture of salt and boric acid was used for the fourth salting and the boron compounds were used alone for the final salting.

*3. Ceramic Bonds.* One of the properties of boric oxide which cannot yet be scientifically explained is its mechanical strength. One finds many claims in the literature that boric oxide imparts "strength" or "toughness" to a glass. Some of these claims undoubtedly are based on the beneficial effect of $B_2O_3$ on the thermal resistivity of glasses, but others are more difficult to interpret, because our knowledge about the effect of glass composition on strength is very meager. In an earlier chapter on the atomic structure of vitreous boric oxide we have quoted Kracek, Morey and Merwin, who made a statement in their paper that vitreous boric oxide is tough rather than brittle and that without being hard it resists crushing to an extraordinary degree.

A few applications of borates, where this toughness is mentioned as one of the chief assets shall be mentioned briefly.

*a). Abrasive Articles.* Alkali borosilicate glasses containing up to 20% $B_2O_3$ are suggested for bonding diamond abrasives. H. R. Houchins (U. S. Pat. 2,334,-266) pointed out that in order to take full advantage of their superior properties, the bonds to be used have to hold the diamond particles in place until they have become dulled by use. Certain borosilicates were found suited for bonding diamonds, because of their wetting properties and toughness. The crushed diamonds (10%) are mixed with a filler (70% fused alumina) and the bonding agent (20% glass) and shaped into grinding wheels. The molded articles are then fired to about 600°C.

*b). Electrical Insulators.* Another group of articles using borates or borosilicates as ceramic bonds comprises various types of electrical insulators. Mica because of its high dielectric strength represents a desirable insulator. For many purposes mica flakes are bonded with organic bonding agents, which of course, do not stand up at elevated temperatures.

Several inventions deal with glass bonds for producing mica insulators (U. S. Pats. 2,032,239; 2,231,-718; 2,391,376) with borates of lead and alkali as the chief ingredients.

A glass which consists chiefly of calcium-magnesium borates with minor additions of silica and alumina is used by L. E. Thiess (U. S. Pat. 2,419,472) for bonding steatite bodies of high dielectric and mechanical strength. L. Navias (2,220,775) developed a glass of the composition 72% $SiO_2$, 8% $TiO_2$ and 20% $B_2O_3$ as a bond for titanium dioxide in the manufacture of electrical insulators having a high dielectric strength, high dielectric constant and low power loss.

*4. Optical Glass.* In the introduction of this paper it was mentioned that boric oxide was first investigated in connection with the development of glasses having new optical properties. The influence which boric oxide exerts upon the refractive index-dispersion ratio of a silicate glass in utilized in several major types of optical glass: Borosilicate Crowns, Barium Crowns and Borosilicate Flints. The chemical compositions of these glasses and their optical characteristics can be found in F. E. Wright's book on "The Manufacture of Optical Glass and of Optical Systems" (1921).

In more recent years boric oxide has become an important constituent of special optical glasses where it is not so much used because of its own optical characteristics but because it provides a convenient "solvent" for elements which ordinarily cannot be introduced in sufficient quantities to produce the desirable properties. Fluorine is a typical example. The introduction of fluorides into soda-lime silicates leads to opacity if their concentration exceeds a certain percentage, approximately 4%. Alkali borosilicates may contain more than 10% fluorine without opacification.

Borates with 40-60% ZnO or 50-80% CdO can be obtained in the glassy state. It is not possible to introduce similar concentrations into silicate glasses. For their use as optical glasses these heavy metal borates have to be stabilized in respect to weathering. E. D. Tillyer (U. S. Pat. 2,254,633) and H. R. Moulton suggests additions of beryllium oxide for this purpose. Glasses containing the borates of cadmium and lanthanum have been studied by K. H. Sun and T. E. Callear (U. S. Pat. 2,430,54). G. F. Brester, N. J. Kreidl and T. G. Pett studied glass formation in the ternary system lanthanum oxide-barium oxide-boric oxide.

TABLE XVII

| Glass Constituent | A % | B % | C % | D % |
|---|---|---|---|---|
| Lanthanum oxide ... | 28 | 28 | 24 | 20 |
| Tantalum oxide ..... | 18 | — | 15 | 12 |
| Tungsten oxide ..... | — | 18 | — | — |
| Thorium oxide ..... | 12 | 12 | 9 | 12 |
| Barium oxide ..... | 12 | 12 | 10 | 20 |
| Strontium oxide .... | — | — | 10 | — |
| Boric oxide ..... | 30 | 30 | 32 | 36 |
| Refractive index .... | 1.745 | 1.725 | 1.720 | 1.702 |
| Dispersion ..... | 47 | 45 | 49 | 50 |

Boric oxide is the glass former of a number of newly developed optical glasses which are often referred to as the "Kodak Glasses". About ten years ago G. W. Morey (U. S. Pat. 2,150,699) discovered a group of glasses

(*Continued on page* 524)

# THE SOLAR HOUSE IS HERE TO STAY

By JOHN L. COX

Libbey-Owens-Ford Glass Company, Toledo, Ohio

**Editor's Note: In the January 1948 issue, *The Glass Industry* carried a critical review of the book, "Your Solar House," in which the reviewer presented his opinion concerning the impractical features of the solar house. Six months after its appearance, it would seem that "Your Solar House" has made a profound impression on architects, builders, suppliers of materials and home owners. Public acceptance of the solar house, it appears, is an established fact and *The Glass Industry* is pleased to publish this latest word on the progress which has been made in this field of modern home design.**

Of vital interest to those in all branches of flat glass is the sharp upswing in the trend toward larger glass areas in residential glazing. This trend, for a long time in the making, has become more and more apparent during the first half of 1948. One of the factors affecting the swing in the direction of increased use of glass in home building has been "Your Solar House", a book published late last year by Simon and Schuster. By the end of June 1948, more than 50,000 copies of "Your Solar House" were in the hands of architects, builders, bankers and general readers.

As the name implies, the new book gives an explanation of the solar house principle and is largely devoted to the reproduction of floor plans and elevation renderings of 49 selected solar houses, one for each state and the District of Columbia. Each design, naturally, embodies an extensive use of glass in exterior glazing.

Indication that the book was particularly timely is found in a review of leading architectural journals which shows that during the first half of 1948 more than 75% of the single family residences pictured or discussed in these magazines have been of the solar type or of designs employing unusually large areas of glass. A survey of the so-called shelter group magazines shows that 63% of the single family residences editorially treated follow in the same category.

The 49 architects whose solar house designs appear in the book were selected by a panel of distinguished architects, teachers and deans of architectural schools and editors. Libbey-Owens-Ford Glass Company commissioned the selected architects to prepare solar house plans suitable for their respective states and made these plans, along with certain technical data, available to the publishers.

A review of the public reaction to "Your Solar House" indicates a remarkable degree of approval and acceptance. Up to May 1, 1948, several hundred written and signed opinions had been received by the publishers and Libbey-Owens-Ford. Included in these are expressions of varying degrees of approval from 436 architects and designers. Thirty-one deans and faculty members of architectural schools signified their approval. Many of these stated that the book would become part of the reference literature of their respective schools. Thirty-one officers of banks throughout the country have expressed approval of the book and its contents. One large New York bank purchased 125 copies to be sent to its correspondent banks throughout the United States so that officials could become conversant with modern trends in residential architecture. This is a significant fact since bankers are understood to be conservative in their evaluation of real estate properties, especially with regard to their worth as financial security. Of equal significance are 25 letters in the same vein from the officials of savings and loan associations and the fact that one group of associations bought 150 copies for its members.

Three hundred and twenty-three individuals in different walks of life wrote letters expressing various degrees of approval. Many of these indicated an active interest in a solar house of their own use.

Twenty-nine glass distributors and forty sash and door concerns expressed their written approval. These two groups considered the book of such importance in the residential building field that they bought and paid for over 2800 copies for distribution to customers, friends and associates. Letters and cards of approval in lesser quantities have been received from newspaper and magazine editors, librarians, curators of museums, state and federal agencies, mirror manufacturers, automobile manufacturers and industrialists of other types.

The appearance of "Your Solar House" was given an almost unprecedented press notice in the newspapers throughout the United States. There is not room to list the names of these publications, but it can be truthfully said that the advent of the book was carried in the news columns of papers in every principal city in the country.

A total of 184 communications have been received expressing disapproval of the book. Sixteen of these, including two architects, were obviously traditionalists who could not accept modern design. Twenty-one individuals, including two architects, completely disapproved for reasons of design. Twelve architects and 54 others expressed dissatisfaction with some portion of the book while endorsing other parts. Twenty-three communications, three from architects, stated that "Your Solar House" should have contained houses in a lower cost bracket. Fifty-nine readers (no architects included) felt the book should have contained more detailed construction information on such factors as conventional heating, plumbing, wiring, wall materials and a host of other subjects beyond the scope of the publication.

Such a preponderance of approval from professional and lay readers seems unquestionably to indicate a growing acceptance of the solar house principle on the part of the American people. Indeed, the trend is international. For example, during the first four months of this year the *British Architectural Review*, being limited by the paper shortage, treated only six single family residences. All of these were true solar houses.

The solar house principle is, of course, not new. Over a period of more than ten years such men as George Fred Keck, Tod Sloan, and others have been planning and building successful solar houses. The data appearing in "Your Solar House" has behind it a study conducted at Purdue University under the direction of Dr. F. W. Hutchinson, professor of Mechanical Engineering,

(*Continued on page* 529)

# INVENTIONS AND INVENTORS

## A Summary of Recently Issued Patents of Interest to the Glass Industry

### Glass Compositions

*pH Responsive Glass Electrode. Fig. 1. Patent No. 2,444,845.* This patent is the invention of George A. Perley of Wyncote, Pa., who assigned it to Leeds and Northrup Company. It relates particularly to glass compositions for use in the membranes of electrodes as shown in an abandoned application filed in 1942 and of which this patent is a continuation in part. The patent states that glass electrodes as formerly known were subject to a large "sodium error" the magnitude of which was subject to wide variation. It provides a glass having a high ratio of oxygen to silicon, the advantages of which are fully set forth in the patent.

The patent gives numerous tables disclosing a large number of different compositions and the characteristics of each. The table reproduced in Fig. 1 will give the general idea of the patent. In this table:—

R is one or more of the metals lithium (Li), cesium (Cs), rubidium (Rb), potassium (K), and sodium (Na);

M is one or more of the metals calcium (Ca), strontium (Sr), barium (Ba), and magnesium (Mg);

X, except as to small quantities of contaminants unavoidably present, is silicon (Si);

GLASS COMPOSITION

| No. | MOL PER CENT | | | | | | AVERAGE MEGOHMS AT 25°C | pH ERROR, 25°C, 2 N SODIUM, 12.8 TO 13.0 pH | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $R_2O$ | | MO | | OM | $XO_2$ | | | | |
| | Li | Cs | Ca | Ba | $La_2O_3$ | Si | | AFTER 2 | AFTER 6 | YEARS 1-2 |
| 69 | 23.7 | 1.7 | 6.3 | 1.5 | 1.9 ($Zr_2O_3$) | 64.9 | 500 | 0.25 | 0.30 | 0.36 |
| 70 | 23.4 | 1.7 | 6.5 | 1.5 | 2.9 ($Y_2O_3$) | 64.2 | 780 | 0.12 | 0.13 | 0.15 |
| 67 | 23.6 | 1.7 | 6.3 | 1.5 | 0.9 ($Zr_2O_3$) | 64.0 | 840 | 0.23 | 0.25 | 0.28 |
| 71 | 24.9 | 1.2 | 6.2 | 1.5 | 4.2 ($Y_2O_3$) | 61.9 | 460 | 0.25 | 0.50 | 0.55 |
| 68 | 24.5 | 1.2 | 4.0 | 0.7 | 2.8 ($Y_2O_3$) | 62.8 | 800 | 0.17 | 0.28 | 0.30 |
| 72 | 24.2 | 1.8 | 9.9 | 0 | 0 | 64.5 | 1100 | 0.30 | 0.33 | 0.38 |
| 110 | 22.4 | 1.2 | 11.9 | 0 | 0 | 64.5 | 2500 | 0.10 | 0.21 | 0.30 |
| 111 | 22.4 | 1.2 | 14.8 | 0 | 0 | 61.0 | 11000 | 0.18 | 0.10 | 0.10 |
| 112 | 24.2 | 1.2 | 6.3 | 1.5 | 2.8 ($Zr_2O_3$) | 63.0 | 270 | 0.33 | 0.40 | 0.46 |
| 17 | 23.2 | 17 (K) | 11.6 | 0 | 0 | 63.7 | 4000 | 0.33 | 0.42 | 0.53 |
| 109 | 20.9 | 1.8 | 14.1 | 0 | 0 | 63.2 | 1600 | 0.28 | 0.30 | 0.33 |
| 128 | 22.4 | 1.6 | 6.9 | 2.5 (Pb) | 0 | 66.6 | 2200 | 0.20 | 0.23 | 0.40 |
| 16 | 23.2 | 1.6 | 6.1 | 2.8 (Sr) | 0 | 67.3 | 1500 | 0.22 | 0.28 | 0.32 |
| 18 | 27 | 1 | 2 | 4 | 1 ($Pr_2O_3$) | 65 | 160 | 0.13 | 0.16 | 0.32 |
| 41 | 26 | 2 | 6 | 1 | 1 ($Pr_2O_3$) | 64 | 700 | 0.12 | 0.16 | 0.16 |
| 114 | 26 | 1 | 3 | 3 | 1 ($Nd_2O_3$) | 66 | 300 | 0.25 | 0.30 | 0.40 |
| 113 | 27 | 1 | 3 | 4 | 1 | 64 | 225 | 0.16 | 0.18 | 0.20 |
| 117 | 26 | 1 | 3 | 5 | 1 | 65 | 160 | 0.15 | 0.15 | 0.15 |

**Fig. 1. pH Responsive Glass Electrode.**

OM is one or more of the oxygen modifiers, consisting of the oxides and rare earth metal oxides herein referred to and producing the herein described beneficial effects accruing from increase in the ratio of oxygen to silicon.

The following references are of record in the file of this patent: United States Patents: 2,311,977, Coleman, Feb. 23, 1943. Other References: "Glass Electrode," by Dole (1941), pages 69, 74, 75, 89, 90. "Journal of Biological Chemistry," volume 81 (1929), page 582; article by Mirsky et al.

*Absorption glass. Fig. 2. Patent No. 2,444,976.* The patent relates to a glass which is substantially transparent in the visible region of the spectrum but which absorbs strongly in the ultraviolet and infrared regions. The invention is concerned particularly with windows in airplanes and it seems to be directed to the prevention of what most of us call "sunburn". In any event, this glass cuts out some of the ultraviolet and infrared rays.

In Fig. 2 there is shown a glazing unit particularly adapted for use in airplanes. The laminated sheet 17 comprises an outer glass sheet 18 which absorbs ultraviolet rays, an inner glass sheet 19 which absorbs infrared rays and an interposed thermoplastic sheet 20. The lower part of the figure shows the means for attaching the unit to an airplane.

One example of a base plate glass batch which may be used is as follows:

| Base Glass Batch | | Base Glass Composition | |
|---|---|---|---|
| | *Pounds* | | *Per cent* |
| Sand | 1,000 | $SiO_2$ | 72.5 |
| Limestone | 350 | $Al_2O_3+Fe_2O_3$ | .5 |
| Soda Ash | 300 | CaO | 13.0 |
| Salt Cake | 50 | $Na_2O$ | 13.5 |
| Arsenic | 10 | $As_2O_5$ | .5 |

The above batch is an ordinary soda-lime-silica plate glass batch and adapted to be added to this batch during the melting thereof are the following ultraviolet cut-off materials:

| | Pounds |
|---|---|
| Commercial titanium dioxide | 120 |
| Commercial cerium hydrate | 40 |

This glass has a golden color and very low transmission of ultraviolet. The following four compositions are examples of batches that may be used to make the heat absorbing glass.

| Batch | A | B | C | D |
|---|---|---|---|---|
| Sand | 1,000 | 1,000 | 1,000 | 1,000 |
| Limestone | 318 | 318 | 300 | 280 |
| Soda Ash | 276 | 249 | 276 | 260 |
| Salt Cake | 50 | 50 | 50 | 50 |
| Salt (Sodium Chloride) | .... | 30 | .... | 30 |
| Borax | 20 | 20 | 20 | 20 |
| Fluorspar (Calcium Fluoride) | .... | .... | 15 | 30 |
| Iron Scale | 9.54 | 9.54 | 9.54 | 8.00 |
| Powdered Charcoal | 5 | 5 | 5 | 5 |
| Percent $Fe_2O_3$ in Finished Glass | .75 | .75 | .75 | .62 |

The following references are of record in the file of this patent: United States Patents: 1,292,147, Taylor, Jan. 21, 1919; 1,292,148, Taylor, Jan. 21, 1919; 1,414,715, Taylor, May 2, 1922; 1,536,919, Parkinson, May 5, 1925; 1,545,509, Montgomery et al., July 14, 1925; 1,572,625, Taylor, Feb. 9, 1926; 1,615,448, Frank, Jan. 25, 1927; 1,634,182, Geil et al., June 28, 1927; 1,637,439, Goblentz, Aug. 2, 1927; 1,771,435, Gelstharp, July

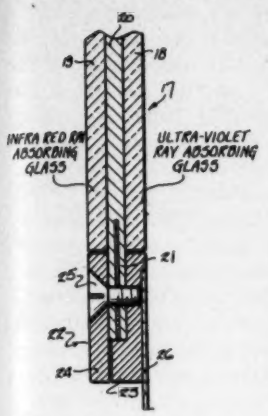


Fig. 2. Absorption Glass.

29, 1930; 1,936,231, Gelstharp et al., Nov. 21, 1933; 1,957,279, Links, May 1, 1934; 1,971,309, Fuwa, Aug. 21, 1934; 2,009,763, Dalton, July 30, 1935; 2,009,764, Dalton, July 30, 1935; 2,035,318, Hood, Mar. 24, 1936; 2,053,244, Turk, Oct. 1, 1936; 2,143,747, Watkins, Jan. 10, 1939; 2,144,943, Sharp, Jan. 24, 1939; 2,145,930, Herron, Feb. 4, 1939; and 2,219,122, Weidert et al., Oct. 22, 1940. Foreign Patents: 114,881, Australia, 1942; 281,249, Great Britain, 1929; 550,782, Germany, 1932; and 673,437, France, 1929. Other References: Anon, Glasind. 26, No. 17/18 (1915 Chem. Abstracts, July 20, 1915, page 1981, 106-52.

**Miscellaneous Processes**

*Electric Glass Heating. Fig. 3. Patent No. 2,445,063.* This invention relates to the heating of cold glass and not to the melting of batch. The inventor is Edwin M. Guyer of Corning, N. Y., and the patent does not show that it was assigned before issue.

A prior patent to Guyer, No. 2,306,054 issued Dec. 12, 1942, discloses a means and method for softening glass by electric conduction heating including the heating of a section of glass to a temperature where it becomes conductive and then passing a current of electricity through the heated portion to increase the heat still further. The present patent improves the method and apparatus of the earlier patent.

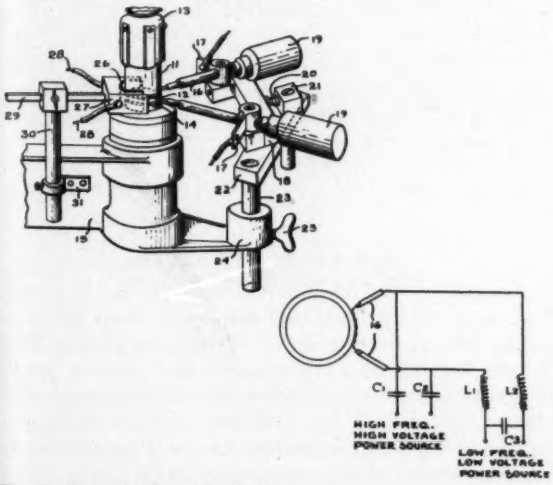


Fig. 3. Electric Glass Heating.

Fig. 3 shows a device for sealing a glass bulb 11 to a pressed blank 12 and a diagram of one form of power connections, there being four such diagrams shown in the patent. The bulb and base are held by chucks 13 and 14 mounted on a base 15 so that they can be rotated at the same speeds. Electrode rods 16 are arranged to be moved by handle 19. A space heater consisting of a resistance band 26 has wires 28 for connection with a source of power. Means is provided for adjusting the space heater in accordance with the work being handled. When the parts are brought close together, they are gently heated along adjacent edges by the space heater 26 after which the glass of at least one of the parts is heated to near melting point by passing a current through the hot glass.

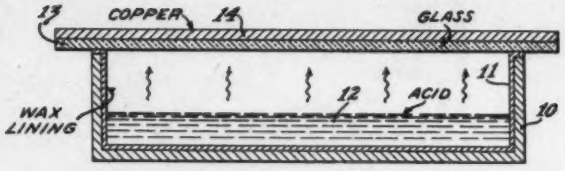


Fig. 4. Low Reflective Film for Glass.

One circuit for this final heating by the electrodes 16 is shown in the diagram where a high voltage, high frequency potential of about 10 K.V. and 1 megacycle is impressed on the electrodes through condensers C1 and C2 which are about 2,000 M. M. F. capacity. When the glass is cold this causes a spark along the surface of the glass between the electrodes which heats the glass so that it becomes a conductor at which time the current passes through the glass heating it to form the seal. Inductances L1 and L2 act as choke coils to prevent the passage of high frequency power. The patent gives complete wiring instructions for the several power connections.

The following references are of record in the file of this patent: United States Patents: 512,604, Coffin, Jan. 9, 1894; 1,107,387, Voelker, Aug. 18, 1914; 1,570,803, Walker, Jan. 26, 1926; 1,587,197, Southgate, June 1, 1926; 1,722,010, Littleton, Jr., et al., July 23, 1929; 1,954,678, Meissner, Apr. 10, 1934; 2,018,056, Delpech, Oct. 22, 1935; and 2,205,425, Leonard, June 25, 1940. Foreign Patents: 86,368, Austria, June 15, 1921 and 516,783, Germany, May 2, 1928.

*Low Reflective Film for Glass. Fig. 4. Patent No. 2,445,238.* This patent is the invention of Frederick H. Nicoll and Ferd E. Williams of Princeton, N. J., who assigned it to Radio Corporation of America. Reference is made to a copending application by Nicoll which shows the treatment of the glass surface by dilute hydrofluoric acid vapor by a method which is difficult to carry out. This patent provides a method which is much easier to practice.

The patent shows three forms of apparatus for carrying the invention into effect, the first of which is reproduced here as Fig. 4. A wax-lined copper tray 10 is 2″ deep by 12″ square and it contains ⅛″ of 16% fluosilicic acid indicated at 12. The glass sheet 13 to be treated is placed in airtight contact with the top of the tray and covered with a copper plate 14. Metal is recommended for the apparatus in order to insure uniform temperature but this may not be necessary. At a temperature of about 25°C. a film suitable for minimizing the reflection of green light will be produced in about 4½ hours. During this process a white deposit is formed on the glass which should be washed off as soon as the treatment is finished.

It is necessary to use care in carrying out this process. The distance between the glass to be treated and the acid is important and the silica content of the fluosilicic acid must be known. The patent gives instructions in

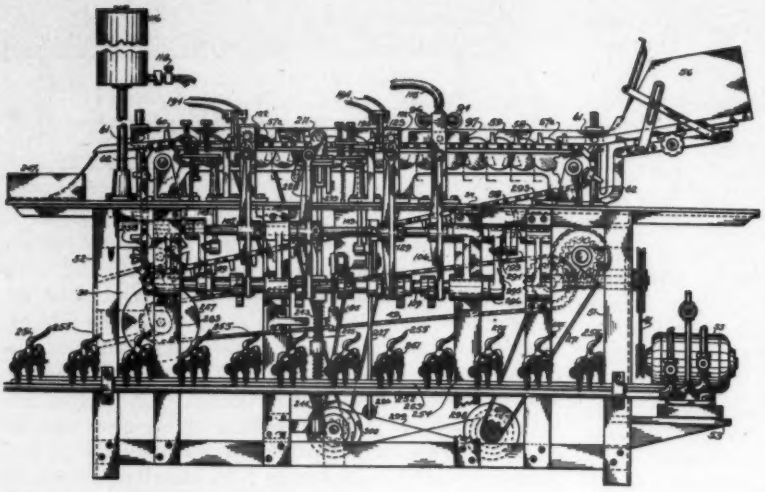

**Fig. 5. Eisler Tube Flanging Machine.**

great detail as to the preparation of the glass for treatment, testing materials used, carrying out the process, etc.

The invention may be seen in condensed form in Claim 1 which is as follows: The method of reducing the index of refraction of a glass surface with an acid vapor derived from a fluosilicic acid solution having between 3% and 10% by weight more silica than called for by the theoretical proportions of the formula $H_2SiF_6$ which includes the step of subjecting a surface of said glass to said vapor, while maintaining said glass and said vapor at substantially the same temperature.

The following references are of record in the file of this patent: United States Patents: 254,263, Bitterlin, Feb. 28, 1882; 1,565,869, Straw, Dec. 15, 1925; 2,215,039, Hood, Sept. 17, 1940; 2,337,460, French, Dec. 21, 1943; and 2,410,300, Nicoll, Oct. 29, 1946.

*Eisler Tube Flanging Machine. Fig. 5. Patent No. 2,446,000.* This patent is the invention of Charles Eisler of Eisler Engineering Co. The machine is arranged to advance a series of glass tubes to several working stations where the tubes are heated, the ends are flared and flanged, the sides of the flange are sheared if necessary and then re-formed and smoothed.

The machine comprises a main frame 50 which carries a motor 55 and the mechanism for handling the tubes. The glass blanks, that is, the tubes to be shaped, are placed in a vibratory hopper 56 from which they are delivered to rollers 57a and 57b which cooperate with a chain 58 having fingers 59. By this means the tubes are moved step by step to the various working stations. Mechanism is provided to position the tubes axially so that the ends are in the right place to be operated upon.

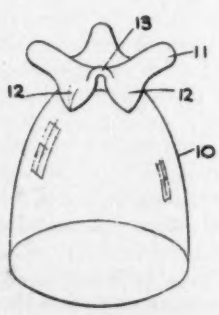


**Fig. 6. Handmade Glassware Method.**

An overhead drive mechanism engages the tubes so that they are rotated at the several working stations at the desided speed. The working parts shown in the patent are adapted to form the ends of tubes into almost any desired shape. Any one interested in the details of this machine should order a copy of the patent at a cost of 25¢ from The Commissioner of Patents, Washington 25, D. C. There are 11 sheets of drawings which disclose the invention in great detail.

The following references are of record in the file of this patent: United States Patents: 1,530,884, Conde, Mar. 24, 1925; 1,906,617, Key, May 2, 1933; 2,234,302, Dichter, Mar. 11, 1941; 1,266,417, Eisler, Dec. 16, 1941; and 2,367,495, Gray, Jan. 16, 1945.

*Handmade Glassware Method. Fig. 6. Patent No. 2,446,359.* This method was invented by Charles W. Carlson of Tiffin, Ohio. The patent states, as is well known, that there is a vast difference in the quality and methods used in the manufacture of machine made ware and handmade ware. The invention seems to reside in the method of sticking on a foot or a stem.

Fig. 6 shows a tumbler, mouth down, having a foot stuck on according to this invention. The bowl 10 is first blown and cooled slightly. The operator then sticks a gob onto the bottom of the bowl and presses it into contact with the bowl where he wishes it to adhere as shown at 12. Then he takes the proper tool to lift up the glass to form portions 13 which make the foot of the tumbler. As the example shown has four feet 13, these must be adjusted to give a firm support for the tumbler.

The patent also discloses a tumbler in which the stem is made about as described above and then a foot is stuck on.

The following references are of record in the file of this patent: United States Patents: Re. 6,151, Oesterling, Nov. 24, 1874; 167,608, Gill, Sept. 14, 1875; and 2,331,413, Model, Oct. 12, 1943.

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## SAM TOUR APPOINTS GLASS SECTION HEAD

The appointment of Howard Kapner to be in charge of the new Glass Section of the laboratories of Sam Tour & Company, Inc., has been announced.

Mr. Kapner, who has made a study and hobby of glass technology for eight years and who has been in the company's laboratories for the last year, will handle all testing laboratory and research work on glass.

***CORRECTION:*** On Page 387 of the July 1948 issue, featuring "First Symposium on Crystal Chemistry Held at Rutgers University," an error occurred in the second column, twenty-second line. This sentence should read: However, in lead glasses, the effect upon $Pb^{2+}$ is the chief factor and the concept of an assymetrical electron distribution in lead explains the vitrification and properties of extreme lead glasses.

# GJ Research Digest

### Load Concentration in Corrugated Paper

In recent years, attention has centered on the protection afforded glass containers and other products by corrugated fiber shipping containers and partitions. In the May 1948 issue of the *A.S.T.M. Bulletin*, J. H. Toulouse and P. J. Barcus report on the results of a study of such protection and the possibility of an objective approach to specification.

The previous method of approach has been one of experience and compromise. Very largely it has been a matter of opinion in which men of experience could easily disagree. In an engineering, objective approach (such as this), differences of opinion can be narrowed down and a broad basis of agreement reached.

Engineering researches using the Inclined Impact Tester (Standard Method of Incline Impact Test for Shipping Containers D-880-47, A.S.T.M.), have shown that where glass containers are concerned, protection was largely a matter of the makeup of the partitions or sheets separating the bottles *within* the same shipping container, the proof being that the breakage usually occurred in a position in the shipping container away from the point of application of external force through crushing of the partition which allowed bottle-to-bottle contact through the crushed partition walls. Therefore, the outer layer of protection is minor and the crush resistance of the partition material is major in importance. With this background, the following is the reasoning in back of the present work:

1) In order to enable uncushioned contact, each bottle is considered to embed itself into the partition stock until it reached the halfway point of the partition, where it meets another bottle moving toward it and also penetrating halfway.

2) The halfway point is one half of the total thickness, less the combined caliper of the facings and corrugating material.

3) When the halfway point is reached, there is a definite area of the bottle in contact with the partition. This area is roughly the chord subtended by the arc of the bottle in contact times the length in contact. As such, it differs with the bottle, being relatively longer with larger round bottles, and of various areas with other than round, cylindrical bottles. It also differs with the thickness of the board, as with *A*, *B*, or *C* flutes.

4) The force which embeds the bottle into the corrugated media is determined by the weight of the bottle and its contents. In general, since most of the weight is in the contents, which may differ according to the specific gravity of the product contained, it is essential to know the weight of the entire package.

5) From this, it is now possible to express the conditions of packaging in terms of pounds of force per square inch of contact area. This may readily be determined for any filled glass container, either by calculation or experiment.

6) Theoretically, the pounds per square inch will range from small values for small capacity bottles to large values for large capacity bottles.

7) The resulting test values on the inclined impact testing machine should range from those approaching infinity, as the load concentration becomes smaller and smaller, to approaching zero as the load concentration becomes larger and larger.

8) Theoretically, the curve expressing such a condition will be a hyperbola.

As a result of previous work by the authors, a number of tests were available in which had been determined the weight of the filled glass package, the area of contact, the load concentration and the average (of ten) inclined impact test for both single wall and multiple wall partitions of the same paper stocks. The latter included single wall partitions of A, B and C flute, with the first two of chip facings and the latter of both chip and 200-lb. test facings. The multiple wall partitions were of both A-B flute double-wall corrugated board with chip facings and two thicknesses of C flute single-wall corrugated board with chip facings.

These experimental results were treated and presented in a statistical manner which was developed by tabular, graphical and mathematic treatments. As a result, the following conclusions were reached:

1) It was shown that the experimental values follow the curve of a hyperbola when concentration of load is compared with conbur footfalls. 2) The curve for single wall corrugated board was distinctly different from the curve for double-wall or double thickness. 3) This makes it possible to specify the kind of interior packing based upon measurement of load concentration (bottle and content weight *versus* contact area), which places specification of interior packing on an objective basis.

(Editor's Note: The authors also suggest that further work is needed to outline the field of application more completely.)

### Liquid Soaps in Glass Containers

In the November 1947 issue of *Soap and Sanitary Chemicals*, H. Kranich discusses, along with other items, the role of the glass container in the formation of a precipitate (with the resulting lack of clarity) in certain liquid soaps and shampoos. This summary will deal only with that part of the investigation in which the glass container was under direct test. (The author also deals with certain sequestering and dispersing agents as a means of preventing cloudiness in such products.)

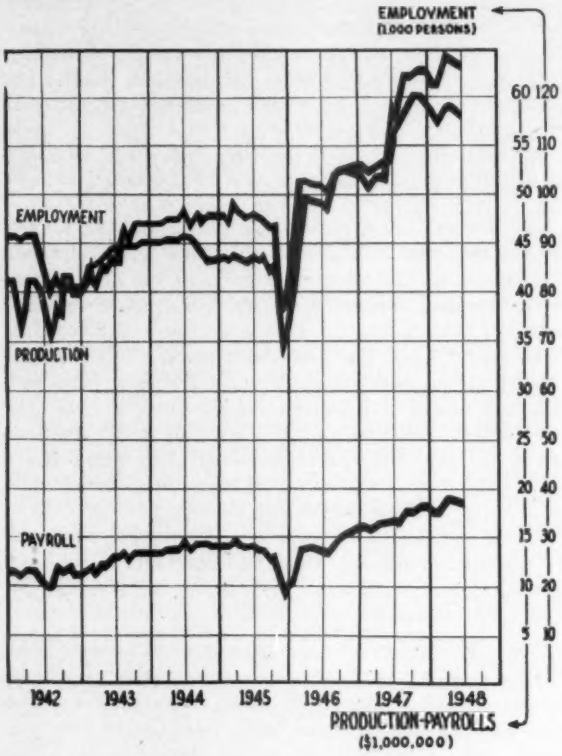
In this investigation, the clarity behavior of liquid soaps and shampoos (stable in steel containers) was tested in a variety of glass containers including Pyrex chemical ware, hand-blown glassware, milk bottles, "green cast" water bottles, commercial bottles of various makes and a number of medicinal and prescription bottles.

Liquid soaps packed in Pyrex type glass, milk bottles,

(*Continued on page* 522)

# CURRENT STATISTICAL POSITION OF GLASS

## THE GLASS INDUSTRY'S INDEX




During the month of June 1948, activity in the glass industry was shown by the Production Index to be approximately $63,300,000. This is about 1 per cent below the $64,000,000 estimated for the previous month. Activity during June 1947 was approximately $59,000,000, which is about 7 per cent less than for June this year. Total estimated production in the glass industry for the first half of 1948 has reached $380,300,000 in comparison with $343,500,000 estimated for the same period in 1947. This indicates a difference of about 10 per cent.

**Employment and payrolls:** During the month of June 1948, employment in the glass industry was 116,500. This is only slightly below the 117,500 reported for the previous month. During June 1947, employment was 120,000, or about 2 per cent more than for June this year.

Estimated payrolls for June 1948 were reported to be $17,750,000, which is slightly more than 1 per cent below the $18,000,000 reported for May. During June 1947, payrolls were an estimated $16,500,000, which is about 7 per cent below June this year. Total estimated payrolls for glass manufacturers during the first six months of 1948 have reached $107,750,000. During the corresponding period in 1947, payrolls had reached an approximated total of $96,500,000, which is about 11 per cent below this year.

**Glass container production** for July 1948, based on figures released by the Bureau of Census, dropped about 4 per cent from the June figure of 8,145,009 gross to 7,784,960 gross. During July 1947, glass container production was reported to be 8,840,014 gross, or about 11 per cent above July this year. Total glass container production thus far in 1948 has reached 57,975,915 gross. This is about 17 per cent less than the 70,397,685 gross produced during the same period in 1947.

July 1948 shipments of glass containers showed an increase of about 1 per cent over June shipments and were reported to be 7,803,461 gross. The June figure was 7,686,682 gross. Shipments during July 1947 were 8,581,079 gross, which is about 9 per cent above July this year. The total number of glass containers shipped during the first seven months of 1948 have reached 56,-

(*Continued on page* 510)

### GLASS CONTAINER SHIPMENTS

(All figures in gross)

| | *July* 1948 |
|---|---|
| **Narrow Neck Containers** | |
| Foods | 893,935 |
| Medicinal & Health Supplies | 751,817 |
| Chemical, Household & Industrials | 442,511 |
| Beverages, Returnable | 838,992 |
| Beverages, Non-returnable | ..... |
| Beer, Returnable | 273,128 |
| Beer, Non-returnable | 450,371 |
| Liquors | 468,989 |
| Wines | 174,934 |
| Toiletries & Cosmetics | 357,521 |
| Sub-Total (Narrow) | 4,652,198 |
| **Wide Mouth Containers** | |
| Foods | 1,944,253 |
| Dairy Products | 227,973 |
| Home Canning | 257,211 |
| Medicinal & Health Supplies | 192,021 |
| Chemical, Household & Industrials | 66,509 |
| Toiletries & Cosmetics | 110,608 |
| Packers' Tumblers | 109,383 |
| Sub-Total (Wide) | 2,907,958 |
| Total Domestic | 7,560,156 |
| Export Shipments | 243,305 |
| Total Shipments | 7,803,461 |

### GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in gross)

| | | *Production July* 1948 | *Stocks July* 1948 |
|---|---|---|---|
| Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries and Cosmetics | Narrow Neck | 2,674,377 | 3,331,262 |
| | Wide Mouth | 2,317,885 | 2,242,000 |
| Dairy Products | | 226,943 | 254,277 |
| Home Canning | | 257,879 | 422,651 |
| Beverages, Returnable | | 857,352 | 805,297 |
| Beverages, Non-returnable | | ..... | ..... |
| Beer, Returnable | | 280,814 | 832,251 |
| Beer, Non-returnable | | 455,033 | 290,608 |
| Liquors | | 432,356 | 248,544 |
| Wines | | 176,148 | 204,909 |
| Packers' Tumblers | | 106,173 | 76,239 |
| Total | | 7,784,960 | 8,708,038 |

# *Reflecting the Integrity of the Maker:*

**Each time you see the Harshaw trademark, whether on tank car, package or small laboratory bottle, remember it identifies chemicals that will help to do a better job . . . truly reflecting the integrity of the maker. • Harshaw will always guard the quality of its chemicals . . . chemicals which you identify by the Harshaw trademark . . . and which you buy with confidence. For more than 50 years Harshaw has persevered in ceaseless research and field investigation. As a result, thousands of manufacturers have been supplied with hundreds of different chemicals which have helped them . . . and which in addition have proved a source of satisfaction to them and to us.**

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TO HELP YOU KEEP PRODUCTION UP COSTS DOWN

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FOR OVER 50 YEARS MANUFACTURERS OF HIGH GRADE REFRACTORIES

**CURRENT STATISTICS . . .**
(*Continued from page* 508)

642,158 gross. This is about 15 per cent below the 66,797,711 gross shipped during the same period in 1947.

Stocks on hand at the close of July 1948 were 8,708,038 gross, compared with 8,809,830 gross at the close of June and 7,060,081 gross at the close of July 1947.

**Plate glass production** for the month of July 1948, according to the Hughes Statistical Bureau, was 17,484,218 sq. ft. This is about 27 per cent below the 24,207,601 sq. ft. produced during the previous month which figure was an all-time high for plate glass production. During July 1947, production was 17,670,240 sq. ft., which is only slightly different from July this year. Total plate glass production thus far in 1948 is 153,172,220 sq. ft., which is about 3 per cent above the 148,138,879 sq. ft. produced during the corresponding period in 1947.

**Automatic tumbler production** continued to drop for the month of July 1948 and was reported to be 3,809,771 dozens. This is about 12½ per cent below the previous month's production which was 4,357,283 dozens. Production during July 1947 was 4,993,181 dozens. Shipments during July also dropped. The July shipments were 4,621,735 dozens, or about 2½ per cent below the 4,742,233 dozens shipped during June. Shipments during July 1947 were 4,346,071 dozens. Stocks on hand at the close of July were 7,241,548 dozens, as compared with 8,154,597 dozens at the close of June and 7,775,388 dozens at the close of July 1947.

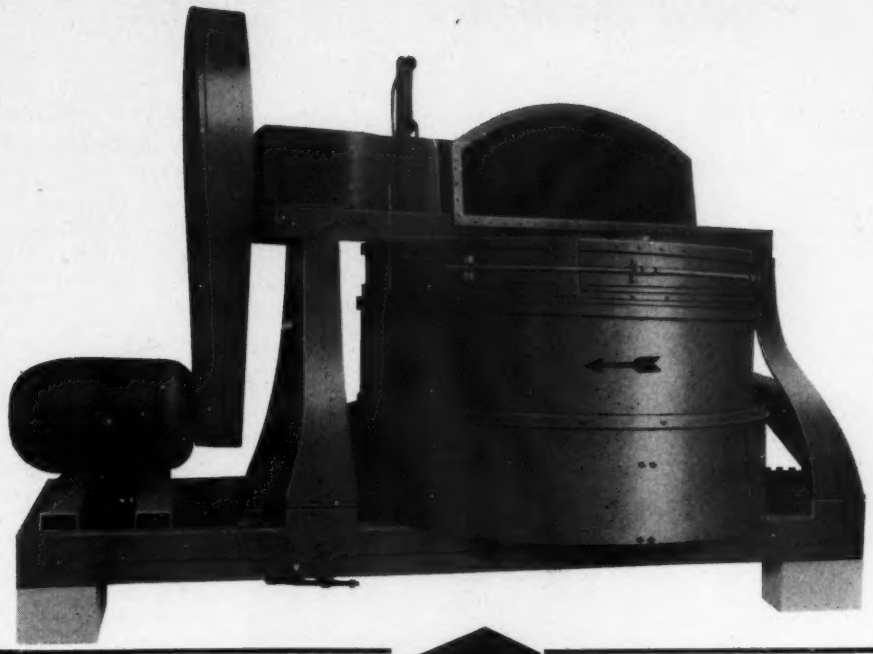
**Table, kitchen and household glassware:** Manufacturers' sales of machine-made table, kitchen and household glassware also continued to drop for July. Sales were 3,040,680 dozens. This is about 9 per cent below the 3,350,944 dozens reported for the previous month. Sales during July 1947 were 2,301,641 dozens. Total manufacturers' sales for the August 1947-July 1948 12-month period were 42,537,332 dozens as compared with 41,807,551 dozens sold during the same period ending July 1947.

---

## PORTAL-TO-PORTAL PAY SUIT AGAINST LIBBEY-OWENS-FORD DISMISSED

Dismissal of the $18,000,000 portal-to-portal pay suit filed in 1947 in the U. S. District Court in Newark, N. J., against Libbey-Owens-Ford Glass Company and on behalf of employees at Toledo, Charleston, W. Va., Shreveport, La., and Ottawa, Ill., has become final when plaintiffs let the appeal date pass without filing.

Originally, the suit was filed by Joseph Froesch, President of the Federation of Glass, Ceramic & Silica Sand Workers of America, CIO, and other union officials on behalf of all employees in company plants represented by the union to recover portal-to-portal or overtime pay for "walking time" and activities preliminary to actual work claimed due from October 24, 1938, to the filing date, March 17, 1947. The suit named an amount in excess of $18,000,000 and asked judgment for an equal amount in liquidated damages, court costs and attorney fees.



Higher Capacity...

Mixing Precision...

# ...PAY FOR THE MIXER!

**(When it's a No. 4½" "LANCASTER")**

***Why? See for yourself . . . check the list of "Lancaster" advantages.***

1. The No. 4½ is a PRECISION mixer for *big batches.* Production is increased *without sacrificing control over the batch.*

2. Batch loss is reduced . . . "corrections" are minimized . . . because *all* "Lancaster" Mixing is uniform mixing.

3. Scientific, intensive counter-current action of the No. 4½ promotes thorough blending of solids and liquid additions where required . . . does not alter or destroy the shape and size of the particles.

4. Operating costs per ton of batch are amazingly low.

5. Batching equipment of the No. 4½ "Lancaster" Mixer fosters economy in materials handling.

6. The No. 4½ charges fast . . . mixes fast . . . discharges fast.

*If you require large-size batches mixed with laboratory precision —write for "Lancaster's" new bulletin No. 71. No obligation.*

## POSEY IRON WORKS, INC.

*formerly* LANCASTER IRON WORKS, INC.

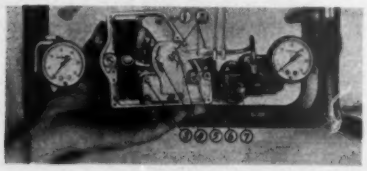
LANCASTER, PENNA., U. S. A.

# NEW EQUIPMENT AND SUPPLIES

## PNEUMATIC CONTROL MECHANISM

Fischer & Porter Company, Dept. 9M-N, Hatboro, Pa., has announced a new Pneumatic Control Mechanism which it is incorporating into all Fischer & Porter flow controlling instruments.

The housing for the unit consists of a one piece die casting which results in all component parts being maintained in a positively fixed relationship



to each other. All important working parts are made from precision castings or heavy stampings, precision trimmed and carefully inspected to assure complete interchangeability, according to the company's report.

The entire assembly may be removed from the control instrument for cleaning or repair without disturbing the process by simply flicking the transfer valve to the "service" position, disconnecting a single air line and removing four screws.

A minimum of tubing connections eliminates air leakage troubles. Absolute alignment of pen and index is certain throughout the range since both index and input links swing on a common center. Valve action is easily reversible without altering link relationships. The pen tracks the set point throughout the 0 to 200 per cent throttling range adjustment. Reset is calibrated accurately from 0.2 to 50 minutes, guaranteeing results the moment the controller goes on stream.

*Illustration Description*: 1) Single piece die cast housing; 2) Concentric input and index action maintains fixed relationship throughout entire range; 3) Control point is not disturbed when valve action is reversed; 4) Control assembly easily removed without shutting down system; 5) Reset speed adjustment calibrated 0.2 to 50 minutes; 6) Automatic-service-manual transfer valve; and 7) 0 to 200 per cent throttling range adjustment.

## RAREOX—NEW POLISHING POWDER

Rare Earths, Inc., R. D. #1, Paterson, New Jersey, has announced the opening of a new plant and research laboratories for the production of its newly developed product, Rareox optical quality polishing powder.

The powder is a combination of the cerium group rare-earth oxides which are fired under carefully controlled conditions in a furnace of the company's own design.

The company also produces rare earth chemicals for the glass and ceramic industries.

## FOXBORO AUTO-SELECTOR CONTROLLER

The Foxboro Company, Foxboro, Mass., has announced the addition of its Auto-Selector Controller to its line of industrial control instruments.

The new instrument controls, selectively, from either of two related variables by positioning a single valve, damper or other operator. This selection is determined by the variable having the greater tendency to exceed its preset limit and the transfer of control is made smoothly, instantly and automatically.

The design of the Auto-Selector embodies two measuring systems and two interconnected Foxboro Model 40 control mechanisms. Control action of both mechanisms may be on-off, proportional, proportional with derivative, proportional with reset (Stabilog), proportional, proportional with derivative, (Hyper-Reset) or any combination of these.

## BRISTOL DEVELOPS PROPORTIONING PYROMETER CONTROLLER

The Bristol Company, Waterbury 91, Conn., has announced the development of a proportional current-input electronic pyrometer controller.

The new instrument proportions the current input to electrically-heated furnaces, ovens, salt pots and other similar equipment to provide practically straight-line temperature control. It does this by time modulation of the input energy. The average energy supplied is proportional to the deviation of the temperature from the control point throughout a band width, which is adjustable from 0 to 2½ per cent of full scale reading.

## CATALOGUES RECEIVED

*The Rapids-Standard Company, Inc.*, Dept. SB-82, 342 Rapistan Building, Grand Rapids 2, Michigan, has issued a two-color, single sheet bulletin describing and illustrating the Stevedore, Jr., power belt conveyor.

The bulletin contains a photograph of the unit in the 11-foot frame length size being used to load a truck and the copy explains the various features incorporated in the conveyor. The backside of the bulletin describes the Stevedore, Jr., in detail and lists specifications of all models.

*Towmotor Corporation*, 1226 East 152nd Street, Cleveland 10, Ohio, has announced publication of a new and revised edition of the Fork Lift Truck Operator's Guide. The guide has been brought up to date and incorporates useful operating hints and instructions in line with modern, approved handling techniques.

In addition to providing instructions for the safe, efficient operation of a fork lift truck, the guide includes sections on standard fork lift trucks accessories and their operation, suggestions for handling materials and containers of all types and a complete section on load-handling techniques.

*The Monarch Machine Tool Company*, Sidney, Ohio, is distributing a bulletin featuring its new Shapemaster Engraver.

The Bulletin, known as No. 2502, illustrates the lathe and gives specifications. Work examples are illustrated with descriptive material giving operational data. A rather lengthy description of the machine and how it operates is included. Fields of application include the glass, plastics and mechanical rubber industries where special mold shapes are required.

*Brooks Rotameter Company*, Box B-70848, Lansdale, Pa., has issued a bulletin concerning its Multi-Range Flow Rate Kit.

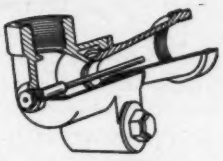
The kit is described and illustrated and discusses Liquid Flow Ranges, Gas Flow Ranges, The Metering Case, Stainless Steel Parts, Meter Supports, Materials of End Fittings, Calibration, etc. It gives a capacity chart for the flow kit and a line drawing gives meter dimensions.

*Wilson Welder and Metals Co., Inc.*, 60 East 42nd Street, New York 17, N. Y., has announced a new 40-page electrode catalogue.

The new catalogue contains 50 photographs and diagrams, an electrode selector chart and complete details on all Wilson electrodes. Typical data given are general description, application, welding procedure, mechanical properties and specifications.

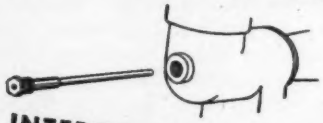
# NORTH AMERICAN *Aspirator Mixers*

## UNEQUALLED *for* EFFICIENCY *or* ADAPTABILITY



### EFFICIENT DESIGN

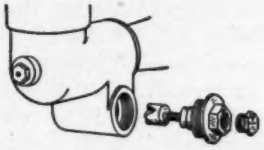
and precision manufacture of the internal parts enable the air flowing through the mixer to create enough suction to draw the gas into the mixer and deliver an intimate mixture of gas and air to the burners at high pressure.



### INTERCHANGEABLE ROD

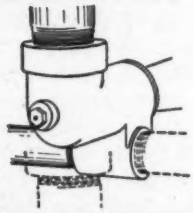
permits changing the orifices to conform to the particular conditions found in the field and still provide the optimum mixture pressure and suction ratios for the job at hand. Standard rods of varying diameters are interchanged without breaking any piping. Easily adjustable for greater mixture pressure with lower suction, or lower mixture pressure with higher suction.

NORTH AMERICAN *for* COMBUSTION



### SENSITIVE V-PORT ADJUSTMENT

provides positive setting of the gas-air ratio on any gas from 500 to 3200 Btu per cubic foot (20 complete turns of the valve are required to go from fully open to fully closed).



### COMPACT, FLEXIBLE DESIGN

makes the North American Aspirator Mixer easy to install on any industrial furnace or oven. Over-all length not excessive.

**THE NORTH AMERICAN MANUFACTURING COMPANY**

MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL

BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES

CLEVELAND 5, OHIO

## A. C. S. GLASS DIVISION AUTUMN MEETING

Program plans for the American Ceramic Society Glass Division Autumn Meeting are getting under way with the meeting, as previously announced, to be held October 8 and 9 at Bedford Springs Hotel, Bedford, Pa.

Thus far, the tentative schedule calls for a luncheon on Friday, October 8, with W. F. Curtis of Fostoria Glass Company speaking on "An Informal Discussion of European Hand Glass Processes." Later that afternoon, a Technical Session will be held at which papers will be presented as follows: F. W. Preston, Preston Laboratories, "Use of Poisson Functions in the Glass Industry"; Stig Lindroth and F. V. Tooley, University of Illinois, "Glass Forming Tendency in System Lime Alumina"; C. D. Spencer, General Electric Co., "A Brittleness Testing Device for Small Glass Tubing"; S. D. Stookey, Corning Glass Works, "Coloration of Glass by Gold, Silver and Copper."

At dinner the same day, the Frank Forrest and S. B. Meyer, Jr., awards will be presented and R. R. Underwood, Knox Glass Associates, Inc., will speak on "Evaluating Accomplishment When Technical and Practical Knowledge Meet."

On Saturday, October 9, a Technical Session will be held and the following papers will be presented: Alexander Silverman, University of Pittsburgh, Pa., "More About the Glass Research Foundation"; H. K. Richardson, Westinghouse Electric Corp., "Burners Used for Lamp Working of Glass"; J. J. Rothermel, University of Pittsburgh, Kuan-Han Sun, Westinghouse Electric Corp., and Alexander Silverman, University of Pittsburgh, "More About New X-Ray Absorbing Glasses"; J. C. Turnbull, Radio Corporation of America, "Recording Dilatometer for the Maximum Thermal Expansion."

A business meeting of the Glass Division will be held on Saturday afternoon followed by a golf tournament.

## LETTER TO THE EDITOR

*Editor,*

THE GLASS INDUSTRY:

I was interested in the brief article which appeared in the August 1948 issue of THE GLASS INDUSTRY entitled, "A Special Method of Glass Melting."

Although the author is, obviously, not familiar with American practice, his suggestion has a germ of an idea. What he really proposes is to do the preliminary melting in continuous tanks and to make the final melting and working from pots. Although at first sight revolutionary, the procedure is really that followed in porcelain enamels and glass fibers.

The economies of melting in a continuous furnace seem obvious. Also to be expected would be less refractory contamination and greater homogeneity. The author failed to mention what might be the greatest boon to the pot houses, longer pot life.

The most direct approach would be for a larger company with excess tank melting capacity to sell prepared frit to smaller hand shops, in much the same ways that large glass plants now sell blanks to shops which specialize in cutting and decorating.

Yours truly,

A Constant Reader

## ALEXIS PINCUS JOINS HORIZONS INCORPORATED

The announcement of the addition to its staff of Dr. Alexis G. Pincus to head the Ceramics Department has been made by Horizons Incorporated.

Dr. Pincus received the degree of Bachelor of Science in Ceramics with honors from Rutgers University in 1932 and the degree of Master of Science from the same institution in 1934. He received his doctorate from Pennsylvania State College in 1940.

Since 1932, Dr. Pincus has been associated with the American Optical Company in its Research Department, directly responsible to Dr. E. D. Tillyer, Director of Research. During 1938-40, he did graduate work at Pennsylvania State College and Massachusetts Institute of Technology, studying and carrying out research under Professors W. A. Weyl, N. W. Taylor, F. H. Norton and B. E. Warren.

In 1940, Dr. Pincus returned to the Southbridge, Mass., plant of the American Optical Company and continued research and development activities on colored and absorptive glasses, optical glasses and glasses of unusual compositions and properties. He was also associated with the development and manufacture of special refractories and of new lens polishing agents.

Dr. Pincus is a member of the American Ceramic Society and has been an abstractor of that Society since 1935. He is also a member of the Society of Glass Technology, American Chemical Society and Sigma Xi. He took an active part in the foundation of the Southbridge Technical Society and Glass Science, Incorporated. He has taught glass technology and enamels at Rutgers and Penn State and has given special lecture series in glass and on atomic energy to technical society groups.

## INTERNATIONAL CERAMIC CONGRESS TO BE HELD IN HOLLAND

An International Ceramic Congress to be held in Holland September 12 through 17, 1948, has been announced. The aim of the Congress is to contribute towards developing the ceramic industry and improving the practical knowledge of ceramics.

The Congress will be divided into four sections: the scientific section, the heavy clay section (comprising the brick, rooftile and stoneware industries), the pottery section (comprising the pottery for domestic and decorative purposes, china and floor- and walltiles industries) and the refractory industry section.

## CLIPPER MANUFACTURING OPENS WEST COAST OFFICE

The Clipper Manufacturing Company has selected San Francisco for its new Western Divisional Branch Office. Mr. William E. Davis is District Manager.

The new factory warehouse and office will carry a complete stock of Clipper products.

UNION PACIFIC

# The Governor of Nebraska invites You

VAL PETERSON
GOVERNOR

STATE of NEBRASKA
EXECUTIVE OFFICE
LINCOLN

To American Industry:

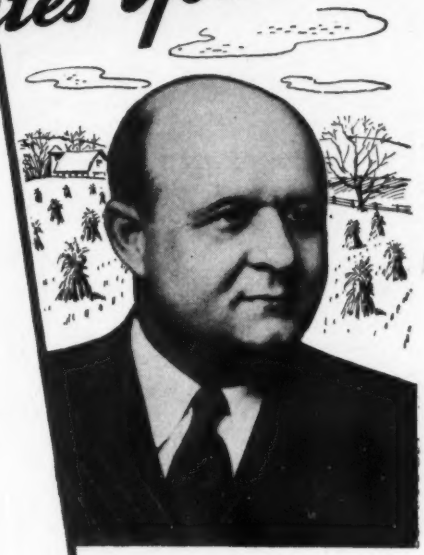
In the last decade, Nebraska's productive capacity has grown threefold. Modern industry has found in increasing numbers that Nebraska's diversified assets form the economic cornerstone of a better tomorrow!

Here there is respect and reward for individual initiative, whether its hallmark be overalls or a business suit. Nebraskans prize ingenuity, cooperation and achievement. Their fundamental faith is reflected by Nebraska government in a conscientious resolve against debt, restrictive taxes and regulatory legislation.

In behalf of all citizens, I invite industry to share Nebraska's unique heritage as the continental crossroads of commerce and heart of a land unmatched in natural wealth.

Sincerely,

Governor



Val Peterson

* One of a series of advertisements based on industrial opportunities in the states served by Union Pacific Railroad.

**Unite with Union Pacific in selecting sites and seeking new markets in California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, Oregon, Utah, Washington, Wyoming.**

***Address Industrial Department, Union Pacific Railroad**
**Omaha 2, Nebraska**

## UNION PACIFIC RAILROAD

*Road of the Daily Streamliners*

## ELECTRON MICROSCOPE INVESTIGATION OF OPAL GLASS . . .

(*Continued from page* 492)

shallow depressions in the glass surface and probably are pits from which the black aggregates have been removed. Second, most of the aggregates do not project high enough above the collodion surface to cast shadows. Electron microscope study of a surface cut perpendicular to that shown would probably clarify this point. If the interpretation is correct that the bodies are disc-shaped, a high degree of orientation exists which would account for breakage along this particular surface. Alignment of the aggregates in chains is evident in the micrograph.

### VI. Particle Size and Distribution

Table II gives particle size data obtained from 26 electron micrographs taken as part of this preliminary investigation. The information can be used in comparing one sample with another and shows the range in particle size that may be expected in commercial opal glass.

TABLE II

| Sample | Crystals | Range of crystal size in $\mu$ | | Average Diameter of bubbles |
|---|---|---|---|---|
| | | Small | Large | |
| 1 | NaF | 0.05-0.4 | 1.2-2.0 | 0.04 |
| 2 | $CaF_2$ | 0.3 -0.5 | | 0.03 |
| 3 | NaF | 0.05-0.4 | 1.0-2.0 | 0.03 |
| 4 | $CaF_2$ | 0.05-0.1 | | 0.04 |
| 5 | $CaF_2$ | 0.05-0.1 | | 0.04 |
| 6 | $CaF_2$ | 0.04-0.1 | | 0.03 |
| 7 | $CaF_2$ | 0.04-0.1 | | 0.04 |
| 8 | $CaF_2$ | 0.05-0.2 | | 0.03 |
| 9 | $CaF_2$ | 0.12-0.6 | | 0.07 |
| 10 | $CaF_2$ | 0.1 -0.7 | 2.0-3.0 | 0.08 |
| 11 | NaF | 0.5 -0.8 | | 0.07* |

*Etched surface

Measurements were also made to obtain the number of crystals and bubbles per square centimeter of surface. The counts vary from $10^7$ to $10^8$ for the crystals and from $10^8$ to $10^9$ in the case of bubbles found on unetched surfaces.

### VII. Summary

The size, shape, and distribution of crystals found in commercial opal glass can be effectively studied with the electron microscope by reproducing the features of the etched or unetched glass surface in a collodion replica which is then shadowed with a metal at a low angle to bring out the relief. In addition to the crystals, features such as bubbles, dendrites, crystal aggregates, globular structures and irregularities in the surface of the glass may be investigated in detail. Commonly the composition of the particles dispersed in the glass can be determined by x-ray or electron diffraction methods, but the electron microscope supplements these techniques by revealing particles or aggregates which do not yield diffraction effects as is the case in samples 12 and 13.

The most common crystals found on the freshly broken glass surfaces of the commercial opal glass samples range from 0.04 to 0.8 micron in diameter. Some of the specimens have, in addition, larger crystals of the order of 1.0 to 3.0 microns in diameter. Bubbles in the glass range from 0.03 to 0.08 micron. Much smaller bubbles and possibly crystals or crystal nuclei undoubtedly exist and may cause the roughness in the glass surface as seen in many of the micrographs.

In the samples investigated a number of characteristic forms appear. In the calcium fluoride opals the common crystal habit is octahedral although cubes and combinations are present in variable amounts. The crystals are sometimes found in clusters but more commonly are uniformly distributed throughout the glass.

Although globular forms are present in calcium fluoride glasses they seem more characteristic of glasses with a high percentage of sodium fluoride. The forms occur in clusters and each globule contains within it or on the edges a number of small cubic crystals. Larger crystals and/or crystalline aggregates with the same shape are often seen and, although on a statistical basis they can be divided into two particle size classes, a gradation exists from particles less than 0.1 to those greater than 2.0 microns in diameter.

Two samples of opal glass with compositions falling within the system $SiO_2$-$TiO_2$-NaF show features of a somewhat different nature.

Bubbles are present in all the glasses and are particularly well brought out by etching.

### VIII. Acknowledgments

This investigation was initiated by Dr. Herbert Insley, former Head of the Department of Earth Sciences, and Mr. F. C. Flint of the Hazel-Atlas Glass Company. The former assisted greatly in the organization of the project while the latter very kindly secured the samples of commercial opal glass together with the chemical analyses and has followed the work with interest.

The authors wish to thank Dr. Woldemar Weyl, Head of the Department of Mineral Technology, for his helpful advise and careful criticism of the paper. Thanks are also due to members of the Division of Ceramics and to Dr. E. F. Osborn, Head of the Department of Earth Sciences, for suggestions pertaining to the interpretation of many of the features of the micrographs.

The samples of commercial opal glass were obtained through the courtesy of the following manufacturers: Anchor Hocking Glass Corporation, Hazel-Atlas Glass Company, Libby Owens-Ford Glass Company and Pittsburgh Plate Glass Company.

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(*Continued on page* 518)

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## ELECTRON MICROSCOPE INVESTIGATION OF OPAL GLASS . . .

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## STANLEY MC GIVERAN NAMED GENERAL MANAGER OF KIMBLE DIVISION

According to a recent announcement, Stanley J. McGiveran, Vice President of the Owens-Illinois Glass Company, has been named General Manager of the company's Kimble Glass Division. He has served as General Sales Manager of the Division since it became a division of Owens-Illinois in 1946.

Mr. McGiveran joined Owens-Illinois in 1927 upon graduation from the University of Wisconsin. In 1936 he became advertising and merchandising director and was named General Manager of the Insulux Products Division in 1938. In 1941 he became Vice President and General Sales Manager of the Owens-Illinois Can Company, serving in that capacity until sale of the Can Company in 1944.

During World War II, Mr. McGiveran served several government agencies, including the War Department, on a consultant basis. At present, he is a member of the civilian advisory committee to the Secretary of the Army developing the recruiting and manpower program for the U. S. Army.

As General Sales Manager of Kimble Glass Division, Mr. McGiveran has contributed to the rapid development of quantity production of the glass television bulbs, a vital part of each television set. He was also largely responsible for the introduction of the popular Opticlear vial which combines the latest developments in both glass and plastic into a virtually moisture-proof container.

## LANCASTER IRON WORKS CHANGES NAME TO POSEY IRON WORKS, INC.

The name of Lancaster Iron Works, Inc., has been changed to Posey Iron Works, Inc. The change was made through action of the Board of Directors in order to honor the President and founder of the organization, W. W. Posey.

There has been no other change in the corporate set-up and the same personnel and management continue to direct the functions of the organization. The various divisions of the company are also being continued.

• Chain Belt Company has announced the opening of a new District Sales Office at 2900 West Clay Street, Richmond 21, Virginia. Fred W. Taylor will be District Manager of this office.

# MELTING

● *The fluxing action of Borax on the batch improves the melting operation and helps to produce a more homogeneous glass of improved viscosity and working properties.*

**Another good reason why Borax should be used as an essential ingredient in the batch formula.**

**Our representatives are prepared to discuss the special advantages of $B_2O_3$ in glass.**

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## BOOK REVIEWS

### Revolution In Glassmaking
By Warren C. Scoville

Liberally sprinkled with tables and charts and photographs, Warren C. Scoville's *Revolution In Glassmaking* comprises a fascinating history of the glassmaking industry between 1880 and 1920.

As might be expected of a volume brought out by Harvard University Press, this book is authoritative and thoroughgoing, and should prove absorbing to business men, economists and historians. It encompasses not only fine details of technology (directly responsible for the development of glassmaking, particularly from 1880 on) but goes into the metamorphosis of labor relationship, labor costs, factory management, output, price, and even into earnings and dividends paid.

From the early days of the pioneer entrepreneur and camaraderie between employer and employee working together in a handicraft industry, to the amassing of fortunes by individual founders of the modern glass factory, the history of glass manufacturing in the United States is the history of the growth of an American industrial empire. The technological progress of glassmaking cast an important influence upon that of radio, television and many other fields of modern scientific and economic endeavor.

Yet the glassmaking industry had, during its growth, to bridge difficulties peculiar to itself in the American business scene, locked as it was in a prolonged struggle to adjust handicraft techniques to a period of technological revolution and growing labor organization. How this was finally resolved, and the leading part a handful of men in Toledo, Ohio, seem to have played in its solution, is American industrial history of importance and of more than ordinary interest.

Published by Harvard University Press, 1948, 398 pages, $5.00.

### The Place of Glass in Building
Edited by John Gloag

A third enlarged and revised edition of "The Place of Glass in Building" has been published and has been planned primarily for students of architecture and building. The edition provides a practical illustrated guide to the chief types of glass manufactured in Great Britain and includes descriptions of their properties and appropriate uses.

The various phases of the book have been contributed by specialists in each particular field. The book, naturally, primarily concerns the use of plate glass and its structural applications. The manufacture of polished plate glass is discussed, as well as flat drawn sheet glass; rolled, cathedral and wired glasses; colored glasses; glass block; and Armourplate glass.

The books illustrates these glasses and after handling the subject from a technical viewpoint, follows with architectural applications, obtaining the greatest amount of daylight from the use of glass and pertinent data concerning the use of glass for building.

Published by George Allen & Unwin, Ltd., 40 Museum Street, London, W.C. 1, England, 122 pages, ten shillings sixpence.

### The Manufacture of Glass
By L. M. Angus-Butterworth

A comprehensive treatise has been prepared by the author presenting the manufacture of glass from the early Egyptian period through the years to present day uses.

Prepared from a "not too technical" viewpoint, the book discusses composition and properties highlighting the principal and most generally used raw materials in glass manufacture. Also briefly handled are devitrification, batch balance, decomposition, hardness in glass, controlled stresses and several other aspects connected with the constitution and properties of glass.

Colors in glass and the process of decolorizing glass are discussed, after which the author launches into a review of glass making equipment featuring the furnace and lehr, with short comment on belt conveyors, stackers and lehr loaders. A chapter is devoted to pyrometers, followed by a review of the batch mixing and handling plant, and glass-finishing machinery.

The book then changes pace and approaches the subject from types of glassware; that is, hand-made tableware and cut glass, pressed glass, window glass making in Britain, plate glass, sheet glass, glass containers, tubing, rod, cane and fibre glasses, architectural glass and scientific glass. Each chapter devoted to these glass products is amply illustrated and discusses operation and special processing required for the particular glass.

Published by the Pitman Publishing Corporation, New York, 274 pages, $6.00.

### Glass, The Miracle Maker
By C. J. Phillips

A revised edition of this well-received book has been issued bringing additional up-to-date information to those interested in glass and the glass industry. Considered a standard reference on glass, the new book also includes a chapter on mechanical properties of glass, chapters on applications and sections on lamp-working and glass-to-metal seals.

Production statistics have been brought up-to-date and there are more than 200 illustrations contained. The revised edition also includes new or additional information on mechanical strength, manufacture of pots, operation of tanks, design of glass melting equipment, dielectric absorption, dielectric constant, power factors, loss factor, use of glass in radio tubes, bent glass for airplanes and automobile windows, silicons and glass-plastics combinations, etc.

The book deals with many of the recent developments in the industry, particularly those developed through the war years when scientists were unusually active in their search for new and improved methods of production. Several chapters have been completely rewritten to bring up-to-date those subjects contained in the first edition in which unusual progress has been made.

Published by Pitman Publishing Company, New York, 429 pages, $6.00.

● Harbison-Walker Refractories Company has announced the appointment of H. L. Smalley as assistant to the vice president, with general supervision over the company's Chicago, Detroit and Indianapolis districts.

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**RESEARCH DIGEST . . .**
(*Continued from page* 507)

hand-blown and prescription glass bottles maintain their clarity for six months or longer. Liquid soaps in other types of glass containers showed varying degrees of cloudiness or milky or red precipitates and gelatinous sediments. Some of the samples showed clarity breakdown within two days when subjected to accelerated aging tests where the product is kept at a temperature of 50-55° C. for 48 to 72 hours with subsequent cooling to 4° C.

A significant observation in all of the tests was that clarity breakdown eventually ceased. The liquid above the precipitate is always clear. If this is placed in a new bottle, it gives a further precipitate which is usually of a lesser degree. This glass erosion in the second container is related to the percentage of ortho-silicic acid found in the clear liquid as a result of the reaction with the first bottle used.

Bottles which gave cloudy solutions were examined for etching. After washing with distilled water and dried, a thin film was observed on the inside surface. Liquid soap in such bottles invariably maintained clarity for long periods of time under both normal and accelerated aging tests which fact allowed the conclusion that the glass containers themselves contributed definitely to the breakdown in clarity of the products.

It was also found that commercial machine-made bottles have deposited on their inner surface a thin film of salts of rather complex nature. This thin salt layer is a major source of trouble in maintaining clarity. If such bottles are washed with a hot or cold dilute acid solution, hot water or wet steam, this layer is removed. Liquid soap in bottles so treated maintain relatively good clarity and stability.

Complaints of cloudiness in liquid soaps and shampoos are more prevalent in the fall of the year. During the relatively higher temperatures of summer, the impurities formed due to glass erosion usually remain in solution. However, fall temperatures (68° F and lower) cause precipitation of these reaction materials.

Chemical analysis showed the precipitates to be composed substantially of calcium and iron stearates, acid stearate soap, silicic acids (meta-gelatinous and ortho-soluble) organic matter, dust and also traces of the rare crystalline potassium di-silicate.

---

### SOUTHERN OHIO AND PITTSBURGH SECTIONS TO HOLD MEETINGS

The Southern Ohio Section of the American Ceramic Society has scheduled a meeting for September 21 in Cincinnati.

Speaker of the evening will be H. M. Kraner, Vice President of the American Ceramic Society, whose subject will be "Patents." Anyone interested in glass or ceramic activities is invited to attend the meeting.

On the same evening, the Pittsburgh Section of the Society will open its 1948-1949 season with its annual stag golf outing and dinner to be held at New Castle, Pa. Being a social event, the program consists of the golf tournament, dinner and an evening of formal and informal entertainment.

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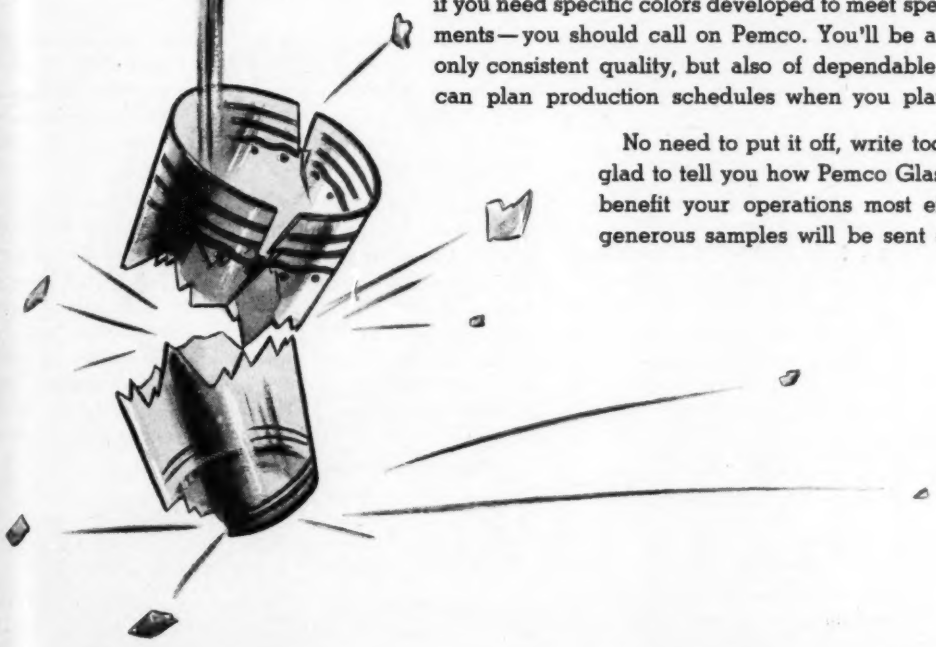

## PEMCO CORPORATION

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(*Continued from page* 502)

which contain lanthanum, tantalum, thorium in appreciable quantities, so that their refractive index is raised above 1.7 without raising the dispersion. Further development by L. W. Eberlin and P. F. De Paolis (U. S. Pat. 2,206,081 and 2,241,249) led to a group of glasses which is exemplified by the four compositions given in Table XVII.

*5. X-ray Transmitting Glasses.* Shortly after the discovery of X-rays by Roentgen (1895), Winkelmann and Straubel published a paper on their absorption by different glasses. This work of the Jena laboratory established the following series of batch ingredients arranged in the order of increasing X-ray absorption. Lithium carbonate, boric acid, sodium carbonate, magnesium oxide, alumina, silica, potassium carbonate, and the oxides of calcium, manganese, barium and lead. The absorption of X-rays is a process which takes place in the interior of the atoms and as such is practically independent of compound formation, but increases with increasing atomic number. X-ray absorption in contrast to the light absorption is a strictly additive property that is one which can be calculated from composition and density.

Based on the experimental work of Winkelmann and Straubel, O. Schott developed a special glass of high $B_2O_3$ content for X-ray tubes:

| | |
|---|---|
| 39.6% $SiO_2$ | 10% $Na_2O$ |
| 30.0% $B_2O_3$ | 0.4% $As_2O_3$ |
| 20.0% $Al_2O_3$ | |

This glass was suitable for blowing and shaping and met the requirements for sealing with platinum (lead-in wires for the electrodes). Later another technique was developed which called for a "window" of high X-ray transmittance to be sealed into an X-ray tube of apparatus glass. A. F. and F. A. Lindemann who invented the new method (Germ. Pat. 223,654) used a borate glass free of $SiO_2$ which contains only lithium and beryllium oxide. The presence of 2-5% BeO increased the stability of the glass but, nevertheless, as a nearly pure alkali borate it was subject to weathering and had to be protected by coating with an organic lacquer. An improved "Lindemann glass" was developed by A. Schleede and M. Wellmann. (Ger. Pat. 537,633) using the following batch composition:

| | |
|---|---|
| Boric acid, $H_3BO_3$ | 18.5 parts by weight |
| Lithium carbonate | 4.3 parts by weight |
| Beryllium carbonate | 1.4 parts by weight |

In discussing the composition of these glasses it should be mentioned that commercial beryllium carbonate at this time contained considerable amounts of alumina and corresponded to a basic carbonate which was not well defined.

More recently two systematic studies of the ternary system $Li_2O$-BeO-$B_2O_3$ were published. L. Mazelev, as well as H. Menzel and S. Sliwinski, examined the borderlines of glass formation in this system and measured the absorption of X-rays, some physical constants and the chemical resistivity of the glasses. Because of their low chemical resistivity a special method for testing these soluble glasses had to be developed.

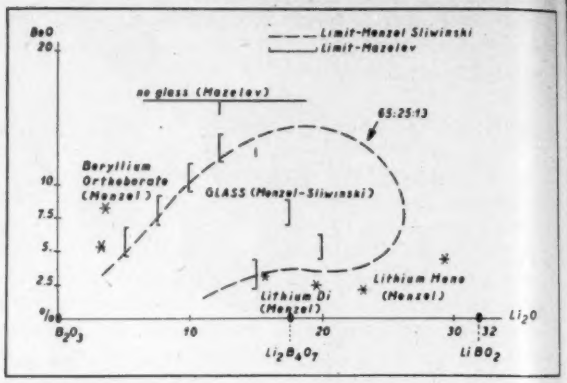


**Fig. 13.**

The compositions of the glasses examined by the Russian and German workers are plotted in Fig. 13. The devitrification products were identified by Menzel and Slivinski as lithium borates, ($LiBO_2$ and $Li_2B_4O_7$) and a formerly unknown borate 3 BeO.$B_2O_3$.

Two glasses recommended by Mazelev for X-ray windows have the following compositions:

| | | |
|---|---|---|
| BeO: 14.1% | $Li_2O$: 17.6% | $B_2O_3$: 68.3% |
| BeO: 12.0% | $Li_2O$: 17.8% | $B_2O_3$: 70.2% |

These glasses have a higher beryllium oxide content than the original (2.5%) and the improved Lindemann glass (Ziegler and Wellmann 4.4%). Their chemical resistivity is therefore much better and the absorption for X-rays only slightly greater than the unstable original glass.

A combination of different alkalies can improve the stability of the alkali beryllium borates but is undesirable for X-ray windows. However, these more complex alkali beryllium borate glasses have been suggested for U.V. transmitting glasses by W. Ziegler and M. Wellmann (1933).

*6. Alumino-borate Glasses.* The Lindemann glasses are lithium borates which were stabilized by beryllium oxide. Wherever the low atomic number of beryllium is not an essential requirement, aluminum oxide may be used instead. For high ultra-violet transmission, for tubes resistant to the vapors of alkali metals and for other purposes where silica is an undesirable constituent, alumino-borate glasses have been developed. One group of alkali lime alumino-borates invented by W. C. Taylor (U. S. Pat. 1,609,329) falls within the following composition limits:

| | |
|---|---|
| boric oxide | 50-57% |
| alumina | 15-30% |
| calcium oxide | 5-20% |
| alkali | 5-20% |

The chemical stability of this group is enhanced by the use of a mixture of $K_2O$ and $Na_2O$ rather than one alkali alone.

The development of fluorescent light sources especially the combination of mercury with alkali metals, e.g., cesium, greatly stimulated the search of new glass compositions with a low silica content. It is characteristic for the alumino borates that most of them originated in the laboratories of leading electrical companies in this country and abroad.

(*Continued on page* 526)

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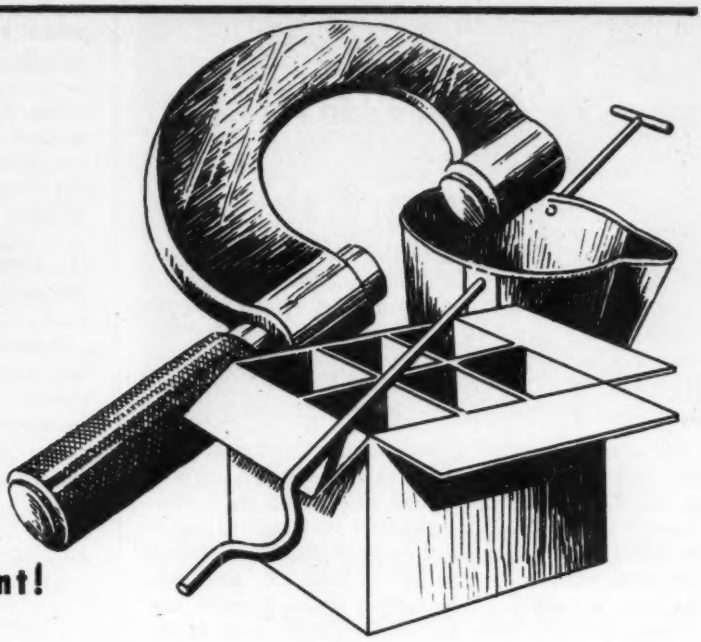

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More than that, Oklahoma has huge deposits of glass sand ($SiO_2$ as high as 99.83%), limestone and dolomite. There is no shortage of natural gas, electrical power or coal. They're all produced right here and at extremely low industrial rates! Corporations get a break too; laws have been revised and are similar to Delaware's! Income tax has been reduced ⅓ with full exemption for federal taxes and payroll taxes average only .08 of 1%!

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# FOR SALE

## GLASS PLANT, CHICAGO HEIGHTS, ILLINOIS

By order of the United States District Court for the Northern District of Ohio, Western Division, Owens-Illinois Glass Company offers for sale as a unit all real estate, buildings, machinery, production equipment (not including molds), tanks and furnaces (except experimental machinery and furnaces) located at Chicago Heights, Illinois, and which were a part of the assets acquired by Owens-Illinois Glass Company from Kimble Glass Company on July 1, 1946.

In accordance with the order of the Court such property is offered for sale for cash to any purchaser approved by said Court, subject to prior sale, at the fair market value of said property as a glassware manufacturing plant, as determined by an appraisal made by The Lloyd-Thomas Company, which said appraisal has been duly filed with the Clerk of said Court at Toledo, Ohio., where it may be inspected. Additions and improvements made to the property described above since July 1, 1946, and prior to consummation of sale are not included in the appraised value aforesaid but are offered for sale as a part of the unit for an additional consideration equal to the cost thereof to Owens-Illinois Glass Company.

In connection with the sale of the property and additions and improvements thereto above described, Owens-Illinois Glass Company will assign or cause to be assigned to the purchaser thereof for the consideration hereinafter set forth, all its rights in and to the following machinery and equipment leased from Hartford-Empire Company situate on said premises on July 1, 1946, to-wit:

4—4 head I S machines with feeders, revolving tube drives and motors, and variable speed drives and motors

1—5 head I S machine with same

2—36" x 74' lehrs, gas fired with top vertical discharge, motor driven steel plate exhaust fan, and all regular equipment

The consideration to be paid by the purchaser to Owens-Illinois Glass Company for the assignment of its rights in the leased machinery aforesaid shall be cash in such an amount as will reimburse Owens-Illinois Glass Company for a fair proportion of any and all payments made in connection with said leased machinery by Kimble Glass Company or Owens-Illinois Glass Company which may be considered as costs of installation, advance payments for minimum annual royalties, license fees, parts, insurance and taxes.

In the event of such sale, possession will be delivered not later than six months after the consummation of such sale to a purchaser approved by the said Court.

Address all inquiries to

Owens-Illinois Glass Company
Attention: F. G. Morfoot
P. O. Box 1035, Toledo 1, Ohio

**BORIC OXIDE — ITS CHEMISTRY AND ROLE IN GLASS TECHNOLOGY . . .**

*(Continued from page 524)*

The usual silicate glasses are severely attacked when exposed to alkali metal vapors. The reaction leads to elemental silicon which darkens the inner glass surface and thus decreases the efficiency of the light source. Alumino borates are fairly resistant towards alkali vapors. Of particular interest are barium containing glasses (L. Navias, U. S. Pat. 2,056,930; E. Berger and W. Harries, U. S. Pat. 2,090,098; W. Haenlein and H. Krefft, U. S. Pat. 2,135,663).

There are several useful glass compositions between the silicates and alumino borates. Most of them have been developed for ultraviolet transmitting filter glasses having a low alkali content.

The low alkali content makes it possible to obtain filters which allow u.v. transmission of about 1% for wave length 185 mμ in one millimeter thickness. According to H. P. Hood (U. S. Pat. 2,382,056) this can be achieved with the following glass composition:

| | |
|---|---|
| $SiO_2$ | 66.6% |
| $B_2O_3$ | 23.9% |
| $Al_2O_3$ | 5.4% |
| $Na_2O$ | 2.2% |
| $Li_2O$ | 0.6% |
| CaO | 0.4% |
| F | 0.9% |

Alumino borates are miscible with silicate and with phosphate glasses. Mixtures of alumino-phosphates and alumino borates have been suggested for u.v. transmitting glasses. This property is the result of the absence of major amounts of alkali oxides.

An interesting group of glasses has been developed by W. H. Armistead (U. S. Pat. 2,417,898). Their compositions are selected so that an aluminum borate 3 $Al_2O_3.B_2O_3$ crystallizes out on cooling. Using lead oxide as a major constituent, the aluminum borate embedded in a matrix of high refractive index produces good opacity. The absence of alkalies causes their expansion to be relatively low. Table XVI gives several glass compositions exemplifying Armistead's invention.

TABLE XVI

| | | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | Wt. % | 30 | 20 | 15 | 30 | 25 | 30 | 20 |
| $Al_2O_3$ | Wt. % | 20 | 20 | 25 | 20 | 25 | 25 | 20 |
| $B_2O_3$ | Wt. % | 5 | 10 | 10 | 10 | 10 | 10 | 20 |
| PbO | Wt. % | 45 | 50 | 50 | 40 | 40 | 35 | 40 |
| Opacity | | med. | med. | dense | med. | dense | dark | med. |

---

● The Glass Guild's pressed and blown glass division is planning immediate construction of a new plant at Stratford, Ont., Canada, to make lenses, crystal buttons and other glass products which were previously imported from Czechoslovakia. Key technicians will be brought to Canada from Europe for the undertaking.

### L-O-F PUBLISHES BOOK FOR EMPLOYEES

The Libbey-Owens-Ford Glass Company has published a book, entitled "We of Libbey-Owens-Ford," which is intended for the new employee. It presents a brief history of glassmaking, tells the story of the company and provides much other information of value to the employee.

The well planned book starts at the beginning by giving the backgrounds of the three founders of the company: Edward Drummond Libbey, Michael J. Owens and Edward Ford. The section on the History of Glassmaking illustrates and describes methods of making glass which have been employed through the years up to our modern day. The various plants of L-O-F are illustrated with descriptive material on each giving the particular processes used at each plant.

Following this is a resume of the products produced by the company, after which the book launches into a discussion of the policies of the company and the part played by the individual employee in the over-all picture. The benefit and insurance programs are discussed, as well as various services, recreational and safety provisions made by the company.

### BUREAU OF STANDARDS COMPILES REFERENCE BOOK

The purchasing agent who wishes to make use of a scientific approach to his problems will find his task has been greatly simplified by the National Bureau of Standards. Use of dependable specifications, the only way to achieve economy in purchasing, has been facilitated through the Bureau's compilation of all the standards and specifications in general use for commodities produced or purchased in this country.

The result is a comprehensive reference book of simplicity and clarity, The National Directory of Commodity Specifications, which briefly catalogues and indexes the information needed in buying all types of products.

The Federal Government is the largest single purchaser of consumer goods in this country. The purchases of an organization of this size can be made to greater advantage under carefully prepared specifications. Prior to 1921, each agency of the Government had its own specifications for all materials it purchased, the requirements often being in conflict with each other and seldom in conformity with commercial practice. To avoid duplication of effort in the procurement of material and to insure better utilization of the national resources and industries, the Federal Specifications Board was established and given the duty of not only compiling and adopting standard specifications but also of bringing them into harmony with the best commercial practice wherever conditions permit. The Board is made up of qualified representatives from the various branches of the Government with the Director of the National Bureau of Standards as *ex officio* chairman.

The National Directory of Commodity Specifications, NBS Miscellaneous Publication M178, and its Supplement are available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. The 1945 Directory costs $4.00 per copy; the 1947 Supplement, $2.25. Questions concerning the Directory should be addressed to the Commodity Standards Division, National Bureau of Standards, Washington 25, D. C.


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**CONTAINER GLASS COMPOSITIONS — 1947 . . .**

(*Continued from page* 494)

for the change in choice of lime are not apparent from the data, but it may be assumed that both economic and technological considerations have played a part.

While it must be admitted that glass container manufacturers were forced to make radical changes in their glasses in 1947 in order to solve problems of raw-material shortages, it is recognized, nonetheless, that the compositions produced represent marked improvements in serviceability, particularly in resistance to thermal shock and to chemical attack. The changes made, no doubt, were larger than would have occurred under normal conditions, but, in view of the advantages gained, it is to be expected that the industry will, for the most part, not merely continue to use the 1947 glasses, but will strive for further improvement by continuing the trends in composition which have become established during the past ten or fifteen years. Certainly there is no sign, at present, to indicate that the glass technologists have exhausted the possibilities for improving American container glasses. In fact, the application of scientific principles and of research results to commercial glass-making practice is of comparatively recent origin. We should, therefore, be able to look forward to many advances and improvements in the years immediately ahead.

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**THE MODERN GAS PRODUCER . . .**

(*Continued from page* 497)

Extensive tests have shown that these generators operate at an efficiency of around 90 per cent when making hot gas and at about 85 per cent when the gas is cooled. On this basis a ton of anthracite will yield 23 to 24 million BTU and a ton of average coke breeze will yield 20 to 21 million BTU.

Frequently, washed anthracite or coke gas is used for applications where sulphur in the gas will discolor or otherwise affect the surface of the product being heated. Sulphur in the form of $H_2S$ may be removed by passing the gas through the well known iron oxide boxes which if not overloaded and properly maintained will give good results. However the gas sometimes will channel through the oxide and occasionally the oxide tends to become compacted reducing its efficiency. Further, the oxide must be regularly regenerated which often is an objectionable procedure and at times accompanied by some danger of explosion or fire. Perhaps the simplest method of removing sulphur is to use a spray pond or cooling tower so the scrubber wash water may be reused and maintain the wash water at a 2½ per cent solution of sodium carbonate. This method effectively removes the sulphur and the solution largely purifies itself when sprayed in the air.

There has been considerable interest in the use of oxygen in the making of producer gas and we were fortunate in having a customer who has used this process for the past several years. In this method a mixture of oxygen and steam takes the place of the usual air-steam mixture for blowing the producer. When using coke approximately 10 cubic feet of oxygen and 1 pound of

steam are required per pound of fuel gasified. The resulting gas is very similar to water gas containing 250 to 275 BTU per cubic foot. A typical gas analysis would be 12 per cent $CO_2$, 0.5 per cent $O_2$, 53 per cent CO, 32 per cent $H_2$, 0.4 per cent $CH_4$ and 2.1 per cent $N_2$.

When using rice size anthracite coal the heating value and composition of the gas is very similar to that obtained when using coke. However, the amount of oxygen is reduced slightly and the quantity of steam increased per pound of fuel.

For applications where the gas is being used for heating purposes the only possible advantage of oxygen producer gas is that slightly smaller gas piping could be used. The increased flame temperature would be of doubtful value.

In any case the present high cost of oxygen, $10.00 to $20.00 per ton, and the very expensive oxygen generating apparatus are an effective economic barrier to the wide use of oxygen. Our customer who regularly uses oxygen for making gas has large quantities of oxygen as a by product from other process in their plant.

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### THE SOLAR HOUSE IS HERE TO STAY . . .

(*Continued from page* 503)

extending over a period of years and utilizing actual test houses. Many of Dr. Hutchinson's findings have been published in architectural and technical journals from time to time since 1945.

It is apparent that "Your Solar House" has had considerable effect on those interested in the improvement of residential design and that the principle of solar housing for residences is rapidly being accepted by architects, builders and home owners. Thousands of solar houses have already been built and will continue to be built in increasing numbers in the future. This will have the inevitable effect of increasing greatly the amount of glass used in each residential unit.

---

### G.C.M.I. ISSUES BOOKLET REVIEWING ONE-WAY BEER BOTTLE CAMPAIGN

Presenting the text of a talk to brewers, distributors and retail operators announcing the new campaign on the One-Way beer bottle, the Glass Container Manufacturers Institute has issued a booklet, entitled "There is a tide . . . ," dramatically emphasizing various phases of the talk.

Numerous graphs and charts are given indicating the trend towards packaged beer, increased preference for beer, etc. The results of a survey made by Elmo Roper on the beer situation in Los Angeles is graphically presented.

The booklet continues with a discussion of the advertisements which are being used in the One-Way beer bottle campaign. Many of the advertisements are illustrated and several are discussed point by point from an "effect on the reader" viewpoint. The entire campaign is covered and, as the text of the talk indicates, prolonged continuation of the campaign is being planned.

• The Wheelco Instruments Company has opened a new office at 138 East Becher Street, Milwaukee 7, Wisconsin. Mr. M. A. Embertson is in charge of the new office.

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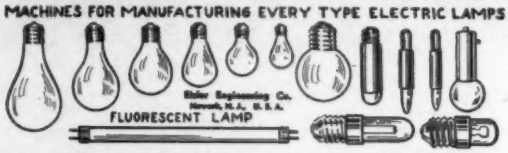
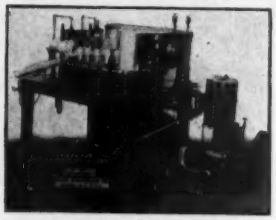



BULB BLOWING MACHINES — AMPULE MACHINES



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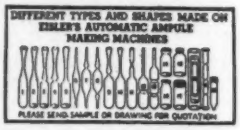
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## FOAMGLAS PIPE-FITTING COVERS

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The pipe-fitting covers are being manufactured in all sizes for Ls, Ts, Unions, Valves, Elbows and Flange Covers. Being of true glass composition, they retain their original insulating efficiency permanently. When installed according to the manufacturer's specifications, the new Foamglas covers may be used through temperature ranges from minus 200 degrees Fahrenheit to plus 800 degrees Fahrenheit.

## ANNUAL PROTECTIVE PACKAGING COMPETITION

The Second Annual Protective Packaging Contest, to be held in conjunction with the Third Annual Industrial Packaging and Materials Handling Exposition and conducted by the Industrial Packaging Engineers Association, has gotten under way.

The competition was developed to inspire the application of sound engineering principles in the packaging field; to foster improvements in the manufacture, design and application of protective materials; and to encourage packaging research. Entries will be judged on factors of safety, economy, ingenuity, ease of handling and conformance to carrier requirements.

Entries will be grouped as follows: *Group 1*: Corrugated or Solid Fibre Boxes; *Group 2*: Nailed Wood Boxes; *Group 3*: Wirebound Boxes; *Group 4*: General Category, and *Group 5*: Export Packages.

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### INSTRUMENTATION COURSE AT TEXAS COLLEGE

The Agricultural and Mechanical College of Texas has scheduled a third short course on "Instrumentation for the Process Industries" for October 26, 27 and 28. The course will be conducted as a seminar with lectures and discussions on the subject of automatic control.

The program will cover a wide variety of subjects, such as measurement and control of temperature, pressure and liquid level, time control and allied subjects. The relationship between practice and basic control theory will be stressed.

### N. Y. DIAMOND ALKALI MANAGER NAMED

Henry B. Clark has been appointed Manager of the New York sales office of Diamond Alkali Company, according to an announcement. Mr. Clark, who has been branch manager of the company's Boston sales office since 1946, succeeds Charles V. Douglas, resigned. Mr. Charles L. Flaccus, Jr., has been appointed Mr. Clark's assistant.

Mr. Clark brings a background of 14 years' sales experience in alkali and related chemicals. Joining Diamond Alkali in 1934, he represented the company in the New Jersey territory until his appointment at Boston in 1946.

Mr. Flaccus has been a Diamond Alkali salesman since 1933 and has worked out of the New York office for the last nine years.


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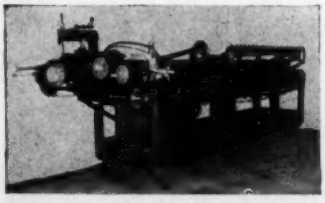

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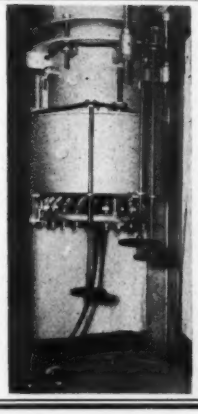

## CLASSIFIED ADVERTISEMENTS

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### HARBISON-WALKER APPOINTMENTS

J. P. Bankson has been named assistant to the vice president of Harbison-Walker Refractories Company. Mr. Bankson was associated with General Refractories Company for eight years and in 1930 joined the Cleveland office of Harbison-Walker as a salesman. In 1935, he was transferred to the Pittsburgh headquarters as district sales manager.

At the same time, the appointment of Harold S. Dunn as Pittsburgh district sales manager was announced. Mr. Dunn joined Harbison-Walker in 1925 at the Portsmouth, Ohio, plant. He was appointed district sales representative the following year, and in 1932 was named district sales manager, which post he held until his present appointment.

• The Rapids-Standard Company, Inc., has announced the adoption of the term "RapiStan" as a trademark to designate all equipment manufactured in their line.

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CONTENTS

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